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Discussion Paper

University Offices for Technology Transfer: Toward the Service University

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UNIVERSITY OFFICES FOR TECHNOLOGY TRANSFER: TOWARD THE SERVICE UNIVERSITY

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FOREWORD

Many Canadians today believe that their country has to make much fuller use of the intellectual capital in its universities as part of its effort to compete effecively in world markets. As international trade in knowledge-intensive goods and services increases, the education of highly qualified people and the achievement of excellence in research are of major economic, as well as social and cultural, significance to Canada. By playing an important role in R&D, the universities have long been of great significance to national economic progress. They have advanced scientific and technological knowledge and trained scientists and engineers.

Today universities in all industrialized countries are being called upon to participate even more directly in economic development. In most of these countries, however, university efforts are complemented by a strong industrial R&D capability. This is less true in Canada. More than other countries, Canada must look to its universities as a source of technological innovation. Consequently, more attention needs to be paid to the economic role of Canadian universities and to the changes needed to develop that role. This is not to say that universities have only an economic role to play, but there is no question that the immediate future of the Canadian university will, as so often in the past, be defined by its utilitarian functions.

The Science Council, because of the significance of the topic for science and technology policy, has examined the relationship between university and industry in such publications as The Machine in the Garden: The Advent of Industrial Research Infrastructure in the Academic Milieu (1984), Challenge of the Research Complex (1981), and the statement of a past chairman, the late Claude Fortier, entitled University-Industry Interaction (1981). Nevertheless, greater importance and higher expectations than ever before are being placed on these relationships by universities, industries, and governments. The growing interest in links between the ivory and office towers prompted the Science Council in 1984 to undertake a major study of the subject from the perspective of making the university a more effective contributor to the Canadian economy.

The study, "University Science and Technology and the Canadian Economy," has two phases. The first is a research effort that is looking into areas of change or potential change in the ways universities and industries interact in Canada. The second phase, which will commence after the research program is completed, is aimed at stimulating and informing the deliberations of other interested parties concerned with the question of university relations with industry. The study aims to provide a better understanding of what is changing or should be changing in university-industry relations, to help resolve the issues involved, and to facilitate the process of change. The Council's intention is not to act as an authority but as a consultant and catalyst by raising those issues important for science and technology policy and having them discussed. The Council will sponsor a number of workshops or conferences for these discussions.

As part of the research for phase one of the study, the Council looked at the organizational changes that several Canadian universities are making to foster technology transfer. The need for research in this area is reflected in the fact that a number of individuals and groups, such as the Canadian Manufacturers' Association, maintain that university-industry cooperation would be more successful if universities had an administrative structure to encourage and deal with industrial contacts (Improving our Industrial Competitiveness: A Science Policy for Canada, February 1986, p. 8).

University Offices for Technology Transfer: Toward the Service University is the first discussion paper to be issued from the study. Offices for technology transfer are only one of the ways in which the country's universities are being organizationally innovative. This paper provides a profile of the initiatives that have been undertaken in this area and indicates their variety. Its primary aim is to assist in the diffusion and development of the offices by raising issues important to their overall development. The paper also considers the offices within the context of the university's mission. Ultimately, their success and effectiveness will depend on how fully they are integrated into the university and its culture.

The study is being developed and guided by a committee of Science Council members: professors Geraldine Kenney-Wallace (chair), James Cutt, Robert Fournier, Jean-Pierre Garant, and Dr Hugh Wynne-Edwards. Dr Gerald W. McIntyre of the Council of Ministers of Education, Canada, participates as an observer.

Dr Philip Enros is a science adviser on staff at the Science Council and project leader of the study. Dr Michael Farley was a project officer for the study and is now on secondment from the Science Council to the Science, Technology and Communications Division of External Affairs.

Finally, it should be noted here that a manuscript report by Dr Niall J. Gogan, The Development of Research Administration and Management in Canadian Universities (November 1985), was prepared as background for this discussion paper. It is available from the publications office of the Science Council.

James M. Gilmour
Director of Research
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INTRODUCTION

The existence of university offices for technology transfer signals the value universities are attaching to interaction with the private sector. Their proliferation, particularly within the last five years, shows how well Canadian universities can respond to a changing economic environment. Despite the significance of the offices, and probably because of their newness, they have not been the object of much scrutiny. The lack of basic information about these offices stands in contrast to a large and growing body of rhetoric on the subject of university-industry interaction. If this discourse is to move forward and lead to needed and productive action, it will have to be better informed. To help satisfy this need, and as part of a larger policy study of university science and technology and the Canadian economy, the Science Council decided to take a close look at university offices for technology transfer as an emerging and significant form of university-industry linkage.

This discussion paper reviews the current state of these offices in Canada. It raises a number of basic issues surrounding their development, including the need for offices for technology transfer, their position within the university, their functions, their means of support, their effectiveness, their impact on the university, and their implications for science and technology policy.

Part 1 situates offices for technology transfer within the context of current concerns about the ways in which Canadian universities are responding to calls for increased interaction between businesses and universities, and about the universities' attitude toward an economic role. Part 2 gives an overview of these offices and provides a comparative analysis of them. It summarizes their major features and establishes a framework for the deliberative questions raised in the last part of the paper. Part 3 discusses the basic issues involved in establishing and operating offices for technology transfer. Appendix 1 provides profiles of the activities of the offices at certain Canadian universities. It presents detailed descriptions of individual offices in their institutional context.

The research for this discussion paper consisted of a literature review and consultations with a number of people and organizations. The primary source of information was a series of interviews with university officials between January and March of 1985. The authors talked with various people responsible for organizing the universities' research activities, such as directors of research administration, chairpersons of boards of research, directors of institutes involved in industrial research, patent, contract and commercial development officers, and vice-presidents or deans of research or their equivalents.

The authors visited the following universities: Alberta, British Columbia, Calgary, Carleton, Dalhousie, Ecole Polytechnique, Guelph, Laval, Manitoba, McGill, McMaster, Memorial, Montreal, New Brunswick, Ottawa, Québec, Queen's, Saskatchewan, Sherbrooke, Simon Fraser, the Technical University of Nova Scotia, Toronto, Victoria, Waterloo, Western Ontario, and York. In addition, all other members of the Association of Universities and

Colleges of Canada were contacted by letter and telephone.

The 15 offices for technology transfer profiled in Appendix 1 are those offices that were discovered during the research period. The situation is, however, changing rapidly and other such offices have been established in the meantime. Because they are not essentially different from those described, they have not been described here, although some are mentioned within the text. Finally, it should be noted that it was not possible, within the scope of this project, to evaluate fully the economic impact of these offices. Also, because the offices are largely an internal university structure, the opinions of the private and government sectors were not solicited.

1. REDEFINING THE ECONOMIC ROLE OF THE UNIVERSITY

Canada, in common with most other industrialized countries, is searching for ways to revitalize its economy. As in other nations, universities are being touted as key players in this process. Nevertheless, there is some resistance on the part of universities to greater involvement with business for fear that it will jeopardize what is commonly held to be the central role of the university, namely, acquiring and imparting knowledge. The risks may even be greater in Canada than in other countries because of the low level of R&D in Canadian industry. Canada may well have to rely more on its universities for technological innovation and to develop dramatically new ways of incorporating business values into them. Despite the fears, Canadian universities are already expanding existing forms of interaction with industry and developing new ones. University offices for technology transfer are one of the most interesting and significant of the new forms.

Importance of Linkages

There is much concern in Canada today about the economic performance of the country's science and technology infrastructure. Economic development increasingly depends on technological change, and R&D is the primary source of that change. Each major sector of scientific and technological activity -- industry, government, and university -- is searching for ways to become more economically effective. At the same time, there is a new understanding of the relationship of science to technology, as well as of both their roles in economic growth. The stereotype of basic research yielding, in a linear fashion, technological innovation is giving way to a view of science and technology as autonomous yet mutually dependent enterprises. In this new model, the health of the R&D system corresponds not simply to the soundness of each component but also to the degree to which each is fully interactive.[1] Moreover, R&D is being recognized as only one ingredient in economic development. Many other factors, including market forces, management and labour skills, as well as financing, are involved.

In response to these changing perspectives and because of concern to revitalize the economy, a shift in the relationships among the three major R&D players is underway. The roles of academic, industrial, and state science are being reassessed, with special attention being given to their interactions. Although it seems clear that science and technology for their own sakes have to be well supported, there is now a pressing need for mechanisms to transfer scientific and technological knowledge to the economy. The maintenance and development of such channels or gateways is considered crucial for high levels of technological innovation and economic development. The university in particular is being affected by these views because the image of it as essentially a generator of new knowledge is giving way to one in which the university is also an active participant in applying that knowledge.

History of University-Industry Relations in Canada

The issue of the relationship between universities and industry, and the complex of questions it gives rise to, came to the fore with the

emergence of modern industrialized economies at the turn of the century. Hence the issue is not a new one in Canada. The Canadian Manufacturers' Association, for example, was calling for closer links between business and higher education in 1900.[2] By 1920 Canadian universities regarded service as one of their primary functions.[3]

Links between university and industry, moreover, did not exist simply on paper. History shows that the two have interacted in a variety of direct ways for quite some time in Canada as in other developed nations.[4] McGill, for instance, set up a department of railway engineering in 1904 with the financial support and technological expertise of the major railways.[5] Queen's University signed a five-year agreement in 1919 (including a clause protecting publication rights) to do metallurgical research for the Deloro Smelting and Refining Company.[6] The long existence of such relationships clearly indicates their fundamental and continuing importance to modern society.

The utility of the universities has been a major factor shaping the evolution of higher education in this century.[7] Sharply contrasted with the more traditional functions of universities, the concept of utility has created a dynamic tension within the university itself, as well as in its relationship with society. The growth of research and graduate studies, the development of professional programs, and changes in the curricula are only some of the ways in which Canadian universities have responded to the demands of their changing environment. Indeed, contrary to the myth, Canadian universities have never been ivory towers.

Present Concerns

With renewed attention to the utility of universities, certain basic questions are being asked once again. What should be the role of Canadian universities in the country's economic development? How can this role best be carried out? These questions are being raised with increasing frequency by many groups in Canadian society today.[8] Responses from university professors, students, or administrators, business people, members of various government task forces or commissions, as well as from the general public, are varied. Some view the university as an ivory tower completely detached from society; others see it as an institution dedicated solely to achieving specific national goals. But these extremes represent the views of minorities. In general, "most university and industry spokesmen agree that the encouragement of increased interaction is in the public and national interest and will become part of the goals of all publicly funded universities in the next decade."[9] Whether the university should play an economic role is not in question; rather at issue is the nature and extent of that role. How should the economic mission of the university best be developed while ensuring that the ways in which it relates to business do not destroy the current strengths of higher education?

Reasons for Current Interest

The current high profile accorded to cooperation between university and industry is essentially the result of an evolving economy, in this case a transition to an information society. But a number of more specific forces are also involved. Chief among these is a sense of impending economic and subsequent social crisis brought on by increas-

ing global competition. Advanced technology is now seen as a means of averting this crisis, a perception that is giving rise to calls for economic restructuring and the promotion of technological innovation. At the same time, the universities are quickly adopting a more positive attitude toward the private sector, and there is growing public awareness that revitalization of the economy can only be accomplished if all sectors of society act together.

These forces in themselves are powerful enough to raise the issue of partnership between the academic and private sectors, but they have been further reinforced by the growing commercial value of certain fields of science. For instance, the central role of microelectronics in technological change coupled with the potential of biotechnology and the strong, direct dependence of these fields on the universities have ensured a prominent position for the universities in solving the country's economic difficulties. Moreover, the universities' own financial problems have also helped motivate change. Together these forces have underscored the importance of the universities as participants in change, raised expectations of their contributions, and stimulated discussion of the extent of their role and ways of carrying it out.

Problems Facing Universities

The calls for greater university involvement in the economy have come at a time when Canadian universities are facing major problems of their own. These include accessibility, autonomy, the financing of research, maintenance of standards, upgrading of facilities and equipment, support of graduate students, an aging professoriate, and the preservation of public confidence. Although all these problems are tied to the financial restraint confronting universities, it seems unlikely that they will be solved simply by increased funding.

Some see strategic planning as the solution to the university's difficulties. Management of the mix and nature of the university's activities, they argue, will be the key to making the university both more efficient and more effective.[10] Better management is a likely part of the solution, but the difficulties facing higher education in Canada reflect a deeper problem, "a more generalized malaise of purpose."[11] Universities must be willing to go beyond the status quo, to search for a new understanding of their position and of the roles they can play in a changing Canadian socioeconomic milieu.

University-Industry Linkages

Stimulated by the external environment, the issue of university-industry relations is one of the challenges facing Canadian universities. A number of ways of fostering increased cooperation that involve various degrees of interaction are being established, extended, or experimented with in the three basic university functions of education, research, and service.

Among the mechanisms for realizing the economic potential of universities are contract research, consulting, patenting, joint ventures, personnel exchanges, continuing education, and incubators (administrative services or space provided for start-up companies).[12] Some believe that "Canada is ahead of all the industrial countries except the United States in actually implementing cooperative programs."[13] Many of these mechanisms are not

new; predecessors for most existed well before the Second World War. What is new is that circumstances have changed and, consequently, these linkages have been greatly extended and intensified. Their potential for the economy is probably greater than ever before.

The present prominence of university-industry linkages has spawned a set of issues around which positions are being formulated. Debate arises on such issues as the free flow of knowledge, academic freedom and objectivity, the direction of research, intellectual property rights, conflict of interest, and nontraditional programming.[14] Some view linkages as dangerous developments; others see them as long overdue. Some believe them to pose irreconcilable differences; others hold that they present no problems that cannot be solved. Like other dilemmas facing Canadian universities, linkages and their ramifications reflect attitudes about the very purpose of higher education and have implications for the definition of that purpose. More than being simply barriers to closer relations, the debates are symptomatic of the changes occurring in universities and indicate the need to reinterpret university roles in the light of such changes.

Economic Potential of University Research

Although research linkages are only one type of university-industry interaction, they are the one that has received the most attention. One reason for this is given by IDEA Corporation in an estimate that suggests that, under the best circumstances, Ontario's universities could generate "500 to 600 new products and processes for licensing to existing high tech firms, as well as 50 new start-up firms" each year.[15] The potential value of research links can thus be seen. In a review of its operating grants program, the Natural Sciences and Engineering Research Council found much transfer activity being conducted informally. Twenty-eight per cent of researchers had transferred research results to an industrial firm during the past five years; 54 per cent expected to do so within the next five years; and 26 per cent after at least five more years of development.[16]

IDEA also offers eight reasons for commercializing university research in Ontario:

- university research is more important for Ontario's economic transformation than it is for other competitive jurisdictions;
- Ontario's economy is comparatively dependent on small and medium-sized manufacturing and service firms, and they could benefit from university technical resources;
- commercializing university research generates jobs;
- Ontario's industries can begin building on existing centres of excellence in university research;
- industry will increasingly gravitate to outside contractors, including universities, particularly for basic or generic research that has high capital and high risk thresholds;
- universities can help companies climb the innovation cost curve, which has become steep in recent years;
- more private sources of revenue for university research must be found; and,
- the opportunity for connecting entrepreneurship to research in universities is here and now.[17]

To a large extent all of these reasons apply to any Canadian province, and because they are widely shared, there has been much activity in forming linkages all across Canada.

Offices for Technology Transfer

One of the more novel and significant forms of university-industry linkage has been the establishment within universities of offices for technology transfer. Technology transfer in this context can be broadly defined as any interaction between the university or its faculty and industry or the community that results in the transmittal of intellectual property in any of its forms.[18] It includes not only the transmission of new knowledge but also the diffusion of current knowledge. An office for technology transfer, in this discussion paper, is taken to refer to an organizational element of a university whose function is to promote and support such interaction at the level of research. This function includes facilitating and managing the transfer of new discoveries to industry so that they can be commercially applied and result in the return of value to the university (usually in the form of royalties).[19] An office for technology transfer can also include other services such as managing contracts, providing information, and putting faculty and companies in touch with one another.

The functions of offices for technology transfer vary, partly because they have been pursued within universities in an individual, ad hoc, or informal way, and partly because the offices emerged only recently in universities, most often from offices of research administration or research services. These latter provide a good point of comparison with offices for technology transfer.

Offices of research administration arose in the last 20 years in association with an extraordinary increase in sponsored research in Canadian universities. They resulted from organizational changes aimed at fostering and organizing research as well as solving the problems associated with increased research activity and funding.[20] As the offices expanded, certain specialized positions developed, such as contract management, international development, and industrial liaison. Some of these functions resulted in separate divisions or offices. Accompanying the emergence of offices of research administration has been the formulation of more explicit research policies as evidenced in the creation of vice-presidents or associate vice-presidents for research, or in the development of industrial strategies.[21] These elements of university research management have also played a part in establishing offices for technology transfer.

Like offices of research administration, offices for technology transfer do not undertake research; rather, they represent a recognition by universities of the importance of the technology transfer process and their need to become more involved in it by providing an organizational structure to accommodate and encourage further partnership with industry.[22] These offices focus transfer activities, pursue the university's economic mission in a much more active way, and exercise control over the uses of university research efforts. But unlike offices of research administration, offices for technology transfer are not

engaged only in administration; the very nature of their activities and goals calls for an entrepreneurial spirit and contact not simply with research but with the whole range of elements that make up the complex process of technological innovation. In this respect they have great potential to influence activities and attitudes within the university.

Toward the Service University

University offices for technology transfer are being set up across Canada. In this simple yet significant way the university is attempting to respond to a changing economic environment. The significance of its response lies not simply in the success of these offices or of other forms of linkage in transferring technology, but in what it expresses about changes in the university itself, especially in its attitudes toward an association with business.

From university-industry interaction and the changing attitudes toward it is emerging a new or modified image of the university, namely, one of that institution as "an underutilized resource which could assume an expanded role in stimulating the economy."[23] This view emphasizes the promotion of economic development as a major theme of the university's mission. Value is to be attached not only to knowledge for its own sake but also to knowledge applied to solve the problems of society. One important expression of this attitude change is the bringing together and fostering of a number of services that the university can offer (such as entrepreneurial, technical, research, training, investment and management services) in order to help business to adapt to current economic circumstances.[24]

Just as the research university emerged in Canada at the start of the twentieth century, perhaps a new species, the service university, is evolving in its last decades. In such an institution teaching and research would not be displaced so much as they would be reoriented. The essence of such a university would be a dynamic, integral relationship with society. Just as the research university underwent structural and functional change, so too will the service university.

> Beyond these many functional changes, there emerges a new model for the universities as institutions without sharp boundaries either in time, in location, or in constituencies. They must become a complex and diffuse network of communication and interaction which not only provides for an outward flow of instruction and dissemination fed from the continuing and essential core of basic research, but which provides as well for a continuous feedback of information about evolving societal needs and circumstances.[25]

At the moment, however, movement in this direction is quite tentative. But offices for technology transfer, in common with many types of university-industry linkage, do appear to be pointing the way in which the modern university will evolve.

Canadian universities are in a state of ferment. They face major problems but also opportunities, provided they are open to change. In the area of economic development, universities are visibly changing through the cultivation of various forms of interaction with business, such as offices for technology

transfer. The challenge will be to fully integrate these activities into the fabric of the university, thereby perhaps even redefining the economic role of the university. To accomplish this will require more information on the initiatives that universities are taking, more informed dialogue reflecting the views of all those with a stake in the outcome, and also considered action.

2. OFFICES FOR TECHNOLOGY TRANSFER IN CANADIAN UNIVERSITIES

Offices for technology transfer are rapidly being established at universities across Canada. As in other areas in which Canadian universities have been organizationally innovative, such as cooperative education, research centres and institutes, and distance education, the offices are one of the ways universities are dealing with current challenges, while attempting to develop their missions further.

Planning for Research

Significant changes have occurred in the last few decades in the ways Canadian universities support, plan, or otherwise manage their research efforts. A variety of new structures and policies have been developed. The appearance of offices dedicated to technology transfer is only one instance of these changes. They came into being in close association with the evolution of university research management.

Because research is one of their core functions, and in response to national policies and levels of funding for research, universities became increasingly concerned in the 1960s with planning and policies for research. A clear expression of their concern was the striking of a commission by the Association of Universities and Colleges of Canada in 1971 to study the rationalization of university research. Among the commission's recommendations were that medium and large universities establish research offices, and that each university, in consultation with governments and other universities, set objectives for its research, keeping in mind its obligations to learning, students, the local community, and the nation.[26]

From that time, a variety of organizational changes were made in Canadian universities to facilitate and foster research. Research boards or standing research committees were established to develop policies related to research, to distribute internal funding, and to respond to government initiatives.[27] At the same time, offices of research administration began to be founded. Today, the majority of universities have research offices whose essential and sometimes single function is to process grants and to help faculty compete for external funds.

Many universities also created the position of vice-president for research, whether assistant, associate or full. Others preferred to appoint deans of research, with responsibilities similar to those held by vice-presidents elsewhere. Their duties include planning budgets, allocating internal funds for research, liaising with governments and the community, implementing university policies, and overseeing or directing offices of research administration. The growth of university research management was accompanied by a corresponding increase in the means used to pursue research; programs, centres, and institutes proliferated.

To facilitate industry's access to universities was one objective of these organizational innovations. The federal department of Industry, Trade and Commerce, for example, set up an industrial research institute program in 1967 that helped to establish 11 such institutes at Canadian universities.[28] The program's aim was to stimulate and aid greater university-industry

interaction in R&D, to market the university's expertise and facilities, and to provide small firms with access to the university's R&D. A number of these institutes were established as components of offices of research administration. The offices helped develop contracting expertise in universities and often served as the natural centres for the growth of more sophisticated technology transfer activities.

The current heightened interest in fostering relationships between universities and industries has been reflected in further changes in how university research is managed. Besides extending and diversifying more traditional mechanisms of technology transfer, universities have developed a variety of novel approaches, such as science or technology parks, incubators, and, of course, offices for technology transfer.

Many offices for technology transfer have evolved from earlier research management structures. Other offices have grown out of different aspects of the university's research planning. They have resulted from rethinking the university's research policy, especially in its relationship to business. Guelph, Laval, Calgary, and the Ecole Polytechnique have published documents on university-industry interaction for research. Simon Fraser is currently implementing recommendations outlined in an internal document. Sherbrooke plans to issue a public statement in the coming months.

All these industrial policy statements contain the same message: Canadian universities must expand their research relations with industry, especially with regional firms. This is best achieved by increasing liaison efforts, by having faculty provide more R&D services, and by commercializing academic research. These activities will not only help Canada's economy grow, but will also render teaching more relevant to student needs.

Some statements also point out priority areas of research of potential interest to industry. For example, in 1971 the Ecole Polytechnique identified the need to concentrate faculty research efforts on such areas as new materials, biotechnology, systems engineering, and telecommunications. These technologies are currently a source of much industrial restructuring in western economies. Clearly, some academic institutions in this country have the research capability and the institutional foresight to engage in planning ahead of future industrial developments, especially those based on technological change.

These policy statements do not represent the attitudes of university administrations alone. They are often based on faculty-wide consultations through surveys or elaborate planning exercises. Both Guelph and Calgary, for instance, consulted extensively with their faculty. Most faculty at these two institutions felt positive toward more involvement in technology transfer. The majority of those surveyed at Guelph "wanted the University to adopt a more aggressive stance in developing interface opportunities and arrangements with industry."[29] Thus the statements indicate the genuine interest of many faculty members in having their work directly related to the needs of society.

Industrial policy statements have important implications for the

organizations involved and for their role in society. A public declaration that is seen to reflect faculty consensus is bound to influence attitudes within the university, especially since these policies promote and stimulate action. Outside the university, business people, politicians, and the general public are less likely to see the university as an ivory tower. The statements provide an opportunity to influence public opinion by presenting a strong image of the university interacting closely with society. In issuing such mission statements, universities also take on a more active role in the national policy process for R&D.

Location

Most offices for technology transfer have appeared at large research-intensive universities, but there are also offices at smaller institutions such as Ryerson and Cape Breton. At the same time, a number of larger institutions do not have such offices. The special characteristics of each university clearly play a major role in determining the presence or absence of such offices. Guelph's history as an agricultural college, the Ecole Polytechnique's as an engineering school, and Waterloo's tradition of cooperation with industry were important factors leading to the establishment of their offices for technology transfer.

In all but one case, the offices have been established within the university itself. The one exception is the University of Toronto's Innovations Foundation, a fully-owned but separate corporation situated off campus. Almost all the others are found within the central administration and are usually connected to the office of research administration or research services. These offices may simply take the form of new positions set up to deal with liaison and commercialization within offices of research administration, such as those at Alberta and British Columbia, or they may be new administrative units reporting to research administration offices, such as those at Guelph and Laval. Still others, for example, those at Queen's, McGill, Calgary, and the Ecole Polytechnique, are more independent, specialized, and diversified.

The provision of technology transfer services may also be found at more decentralized levels of the university. Some medical faculties have set up offices of research whose main function is to process grants. The special linkage problems associated with commercializing medical research (for example, the state of Canada's health care industry, the relations of hospitals to universities, the need for clinical trials) require, perhaps, that technology transfer experts be more closely associated with faculty in this area. The Medical Research Office at Toronto has made it a goal "to encourage a more entrepreneurial mindset" among researchers. Administrators at Toronto are currently attempting to place liaison activities on a more formal footing. They will also draw up an inventory of research that has commercial potential.

Another example of an office at the faculty level is at Saskatchewan, where the College of Agriculture decided to set up a research office to manage the $7 million FARM/LAB Program sponsored by the provincial government. An associate dean was appointed director, whose job it is

to process the hundreds of project contracts and to carry out liaison between farmers and researchers.

Offices also exist at the departmental level. This often enables a very close relationship between the offices and faculty members. Departments in the faculty of engineering at Manitoba have advisory committees composed of faculty and business people. Together these committees form the Faculty-Industry Liaison Committee. Perhaps the best example of an office at this level is the Waterloo Centre for Process Development. It is located in Waterloo's department of chemical engineering and offers independent liaison, contract, and commercialization services to the faculty. The centre also formulates and implements some policies, such as charging outside contracts 100 per cent overhead.

Functions and Structures

Although all offices for technology transfer have the same objective (to transfer technology), the ways in which they attempt to achieve that goal vary. Their activities in general encompass the full spectrum of technology transfer services both inside and outside the university. Inwardly oriented activities include increasing faculty awareness of the value of interaction with the private sector by identifying commercially significant research, advising or assisting faculty in commercialization, screening inventions, providing expertise in marketing, or by getting involved in the development of innovations or the establishment of spin-off companies.

Outwardly oriented activities include liaison, brokerage functions, or maintaining links with external groups for advice and services. This last activity includes connecting with the existing network of expertise provided by federal agencies, such as the National Research Council or Canadian Patents and Development Limited; by provincial research organizations or programs such as the Centre de recherche industrielle du Québec; or by the two industrial innovation centres at Montreal and Waterloo. It can also mean involving private groups. Calgary, for example, has a technology transfer advisory group and Queen's makes use of a group of retired business people.

Offices for technology transfer have not only a wide range of functions but also a broad range of organizational structures. Laval's new office includes all aspects of technology transfer services: liaison, contracting, patenting, licensing, supporting new businesses, implementing policies, and so forth. McGill and the Ecole Polytechnique provide the same services in specialized units. McGill has one office for contracting, a second for commercialization, and a third for liaison in the area of biotechnology. The Ecole Polytechnique has one office for contracts, commercialization, and support of spin-off firms and another for cooperative ventures. The offices at Guelph, Queen's, and Calgary all specialize in liaison and commercialization, while their central research offices continue to handle contracts.

Developmental Influences

A number of factors have influenced the development of offices for technology transfer, one of which is the complexity of technology transfer itself. Technology transfer is a time-consuming exercise and requires the talents of rather special individuals who are equally acceptable to faculty and the business

community. Such people are hard to find. Another problem has been that offices must not only produce but must also work to become self-supporting within a limited time. In addition, their development has often been hampered by the particular culture of the university or by suspicious or hostile attitudes toward such offices.

Other factors, however, have played a positive role in developing the offices. As faculty have become more alert to the commercial potential of their work and more interested in interacting with external groups, their demands for assistance have increased and the volume and range of office activities have grown. The foresight of university research managers has also been a positive factor. Many of them have attempted to provide technology transfer services, to gain control over technology transfer efforts, or to better realize the potential of these efforts.

The difficulties involved in setting up offices for technology transfer are probably the reason why several universities that want them still do not have them. Even universities with offices are having problems in further developing their functions. Waterloo, Alberta, British Columbia, and Concordia all feel the need to improve patenting and licensing services, which, as they exist at present, can hardly meet faculty demand in their institutions. McGill and Montreal expressed a need for expertise to manage risk capital funds in support of faculty efforts to commercialize research. McGill's office of biotechnology identified the need for another type of expertise scarcely found in the universities: qualified research and technology assessment skills for properly marketing the universities' research resources. The universities are also short of legal skills, which they urgently require in negotiating licences and joint ventures.

Impact

Determining the impact of university offices for technology transfer is a difficult and complex task. An evaluation would require reviewing the effectiveness and efficiency of the offices, determining their major consequences, and interviewing all involved, from students to business people. The task would be further complicated by the newness and diversity of the offices. Although this study did not set out expressly to determine the impact of university offices for technology transfer, it is worthwhile to indicate the major areas of impact that need examination and to point out some achievements.

The achievements of the offices in transferring technology can be measured by evidence of increased commercialization, benefits to the economy, and financial returns for faculty and the university. But there is another set of effects that is less tangible yet equally important, namely, the degree to which the offices have shaped attitudes toward the university and changed its organization and activities. Although the offices are still fragile and somewhat marginal to the main functions of the university, they have the potential to help redefine that institution. Perhaps more than other mechanisms for technology transfer, they are creating an environment within the university that is conducive to redefining its mandate and "'lowering the threshold' to commercial interaction at all levels."[30] Thus the impact of the

offices on the teaching and research programs, as well as on the attitudes of faculty and students toward interaction with industry, needs to be explored. These results of the offices may well turn out to be the most significant.

Some outcomes of the offices for technology transfer are already quite visible. All universities that have introduced such offices have increased industrial services to faculty and registered a rise in demand for these and other services. The offices have contributed significantly to improving industrial liaison and to commercializing faculty research. Since the establishment of a contracts office in 1971 at McGill, the number of contracts awarded to professors has grown from 23 to over 100 annually. Toronto's Innovations Foundation has examined over 300 inventions in the past five years of which 211 are being patented or licensed. McGill's inventions and patents office (established in 1984) has already investigated 40 innovations, processed 10 patents, and signed two licences. UBC's industrial liaison office (established in 1984) is currently handling 17 patent applications, has signed 10 licences, and is involved in setting up a spin-off company. The office at Alberta is currently negotiating with principals in the university and in the private sector to establish two spin-off companies near the campus.

The offices have produced financial returns as well. Guelph's office of industrial services (established in 1983) is largely responsible for a 147 per cent increase in research funds from the business sector. Royalties from eight licences held by the Waterloo Centre for Process Development (WCPD, established in 1978) bring in over $500 000 a year to support faculty research at that university. Calgary's office of computing technology (which manages the advanced computing technology centre established in 1984) declared a profit of $900 000 last year, of which $230 000 has been made available to administrators to set up two research centres. This office, like the Innovations Foundation at Toronto, the Waterloo Research Institute, and McGill's inventions and patents office, is self-supporting. Moreover, some (such as the WCPD, which advances $300 000 a year to the university for infrastructure costs) are a source of revenue to the university.

Role of Government

Over the past few years many government policies and programs for university research or economic development have emphasized the need to make faculty research efforts more focused and to transfer results to the marketplace. Originating from both the federal and provincial governments, these policies and programs have been a major stimulus and a great aid in establishing university offices for technology transfer.

The federal government has created a number of programs aimed at fostering industrial research and development. The most important programs, from the standpoint of university offices for technology transfer, are known collectively as technology centres. These were offered by Industry, Trade and Commerce (IT&C) and later by the Department of Regional Industrial Expansion (DRIE). Technology centres are intended to encourage innovation and technological development in Canadian industry. Their emphasis

is not on doing research but on "identifying, transferring and diffusing to industry technologies developed in universities, government labs, research centres and private firms."[31] Intended to become self-supporting within a fixed period, the various types of centres have received $33 million from IT&C or DRIE between 1967 and 1984.

Three types of technology centres are relevant to the offices for technology transfer: industrial research institutes, industrial innovation centres, and centres of advanced technology. The first type has already been described.

There are two industrial innovation centres: the Canadian Industrial Innovation Centre, Waterloo (CIIC/W) (established 1978) and the Centre d'innovation industrielle (established 1981) in Montreal. The task of these centres is to stimulate the entrepreneurial process. They offer a variety of services to the entrepreneur such as advice and assistance in setting up and operating new companies to exploit technology. They also perform invention evaluations and market assessments, help inventors to get their inventions to the marketplace, and help entrepreneurs to establish new companies that market products or services based on new technology.[32] These two centres seem to have inspired a number of universities to set up their own innovation centres.

The third type of technology centre is the centre of advanced technology (CAT). Although such centres were intended to operate R&D facilities in specific technologies of importance to Canadian industry, at least one centre, the Waterloo Centre for Process Development, acts as a broker between the university's expertise (here, chemical engineering) and industry. It is surprising that more CATs have not adopted this function of the Waterloo centre.

Technology centres may be viewed as precursors and even as models for the active outreach technology transfer activities of many universities. They also underline the importance of the special funding needed to make offices for technology transfer operational. Requests for certain types of technology centres are still being considered, but are now under the administration of economic and regional development agreements. For example, the agreement between British Columbia and Canada in November 1984 included a provision for the establishment of university-industry liaison offices at the University of British Columbia, Simon Fraser University, and the University of Victoria at a cost of $4 million over five years. Another example is the Canada-Saskatchewan Subsidiary Agreement on Advanced Technology signed in 1984. Under this agreement, Saskatchewan has established offices of university research at the universities of Regina and Saskatchewan. These offices will carry out technology transfer and in particular will act as contract research offices similar to the industrial institutes at other Canadian universities.

One other federal program needs to be mentioned. The National Research Council's Industrial Research Assistance Program (IRAP) was established in 1962 to encourage R&D in Canadian industry. One element of this program, the field advisory service, can help foster university-industry linkages. Many of its field representatives are located at universities where they often deal with university technology

transfer offices, thereby strengthening the university's research outreach infrastructure. Another element of IRAP is the laboratory network program, formerly a part of the Program for Industry/Laboratory Projects (PILP). It has contributed to establishing or extending various university offices for technology transfer across the country.

All provincial governments also have their own programs to help industry respond to technological change. Some of these are aimed at better equipping the provinces' universities to transfer their research. The Centre de recherche industrielle du Québec (CRIQ) has technology transfer agreements with some universities. In collaboration with research offices, CRIQ provides faculty with services to help them commercialize their inventions. The Quebec government also provides funds to support the technological innovation office at the Université du Québec à Chicoutimi.

The Department of Economic Development of Alberta periodically seconds personnel to university offices for technology transfer to take up positions as industrial liaison officers. At present, the University of Alberta benefits from the services of one officer who spends two to three days there each week.

Ontario has two programs relevant to technology transfer: the IDEA Corporation and the Ontario Innovation Centres. The IDEA Corporation was set up in 1982-83 primarily to advance the process of commercializing technology. In 1984 it established a commercial development officer's program funded at $3 million over three years to help Ontario universities identify and commercialize early-stage research. As of November 1985, 10 universities had signed agreements under this program: Carleton, Guelph, Lakehead, McMaster, Ottawa, Queen's, Toronto, Waterloo, Western, and Windsor. In 1985 IDEA established two experimental seed capital funds, one at York University and the other at the Innovations Foundation of the University of Toronto, to help develop business information for some university research projects.

The Ontario Innovation Centres Program was set up by the Ministry of Industry, Trade and Technology in 1984. It arose from a concern that only limited results were being achieved in capitalizing on the research and resources of Ontario's postsecondary institutions in the innovative process. Its purpose, therefore, was to stimulate the process of innovation by providing focal points for the commercialization of products, processes, and services. This approximately $7-million program funds 20 centres at 22 postsecondary institutions on a shared cost basis for a three-year period. Appendix 2 lists centres located at universities and their particular emphases.

3. ISSUES FOR DELIBERATION

Offices for technology transfer have emerged at a number of universities in Canada, partly as a response to changing economic circumstances. As a new initiative, they exhibit wide variations and have yet to take full root in their institutions. In their struggle to define themselves and develop further, the offices face many difficulties. They are not always viewed as legitimate or permanent parts of the university. Most are not financially secure. There are also conflicting ideas on how they can operate most effectively. Therefore, there is a need to take stock of their collective experience and to consider directions for the offices' future development. These deliberations, moreover, should involve everyone with a stake in the future of Canadian universities.

Each of the following five sections focuses on a key area of concern and raises related questions. The text is not intended to provide answers to these questions, but to elaborate on them and to indicate some of their more interesting features. The first section deals with the most basic issue, the existence of the offices. The remaining sections pose questions on how the offices may be aided or made more effective. The questions raised here will, it is hoped, stimulate and assist in discussion of the offices and thereby contribute to well-founded decisions about their future.

Establishment

Should universities establish offices for technology transfer?

On first consideration, the question of whether the universities should set up offices for technology might appear rhetorical. After all, several Canadian universities have already established such offices. But it is a legitimate and fundamental question deserving thoughtful consideration. The answer must take into account the need for university offices for technology transfer as well as the consequences of their establishment. It will also be based on underlying assumptions about the role of universities. These assumptions will have to be brought to the fore and fully discussed. Evaluating the need for and consequences of the offices will largely depend upon perceptions of what the role of Canadian universities should be.

How necessary are these offices?

Some see university offices for technology transfer as merely the products of a period of financial restraint, that is, either they are being forced on universities or universities are setting them up in an attempt to find new sources of income. Although the financial crisis facing universities has undoubtedly been a motivating factor in establishing the offices, it has not been a sufficient cause. A number of external and internal forces have also been at work, as reviewed in Part 1.

Technology transfer has come to be recognized as an important yet neglected function of the R&D system. Many believe that Canadian universities can and probably need to be further integrated into that system's economic stream and, consequently, are calling for closer ties between business and university. Furthermore, the educational function of the university can itself be a force for

greater orientation toward the needs of industry. As Gordon Maclachlan has pointed out,

"This is the world in which graduate students are going to be working after university, and we have an obligation to help train them with the skills they will need. I do not mean just the obvious techniques, like how to use a computer, I mean the mind-set, the attitude, the background knowledge, the social consciousness, the independence and the confidence that they should have to cope with the demands and stresses of a rapidly changing world. We cannot lock ourselves up in a gilded cage or an ivory tower as if the world frightens us. We have to cultivate an inventive outgoing imagination and the attitude that the most complex and daunting situations are not problems but great opportunities for new solutions."[33]

The offices, then, are more than a response to inadequate financing. They are a response to a variety of needs, both outside as well as within the university.

What are the consequences of establishing offices for technology transfer?

University offices for technology transfer affect the universities in two main areas: in transferring technology to industry and in influencing attitudes toward interaction with industry. With respect to the former, there has been no real attempt to evaluate the effectiveness of the offices, but one indicator of success is the ability of some offices to become self-supporting after initial assistance. Since they are still so new, it is difficult to judge whether the offices will be able to remain self-supporting. It is even harder to estimate how much money they will be able to generate for their universities. Their achievements and failures in trans-

ferring university technology and knowledge will have to be examined in evaluating their economic impact.

An indirect but equally important consequence of the offices is their effect on attitudes toward university relations with industry. The offices can help change negative perceptions of the universities on the part of business and the public. Positive changes will bring down barriers to collaboration.[34]

Likewise, the university's attitudes toward industry can also be changed. Offices for technology transfer motivate faculty and students to solve industrial research problems and commercialize research results. There are indications that faculty members are increasingly interested in drawing financial rewards from their work. The new generation of students is already more business-oriented.

Although the offices are not solely or wholly responsible for making attitudes more positive, they are certainly involved in reinforcing this change. Their actual impact and influence on shifting viewpoints also needs to be evaluated.

To what extent are the risks involved in establishing the offices worth taking?

As with other forms of linkage with industry, the greatest concern about offices for technology transfer is over their impact on the core values of the university. Increased relations with business call for a clearer understanding of what is involved in such issues as conflict of interest, secrecy, and unfair competition. These issues, however, are probably less relevant to the offices than to other kinds of linkage, since their primary goal is to provide services for faculty. Furthermore, as an integral part of the university, control over their

activities can be exercised by the university according to its policies.

Does society's understanding of the university's mission need extending?

The risks involved in setting up offices need to be compared to the benefits, both actual and potential. Perhaps greater risks need to be taken by Canadian universities because of the weakness of Canadian industry. When considering difficulties, the flexibility of the university should also be kept in mind. The university and its values are not fixed: they have changed in the past and can do so in the future. Difficulties need not indicate dead ends; they may also signal areas in which values need to be re-evaluated.

Does the process of consultation sometimes involved in establishing the offices need to be more widely adopted? Should it be extended to include the views of students and the public?

Whether the offices are appropriate for universities is determined not only by the need for them but also by the culture of those institutions. Some elements of that culture can be specific to an individual university. This explains in part why some Canadian universities have not established offices for technology transfer.

Some universities have attempted to work within their culture in setting up offices. They have consulted their faculty extensively in order to reach a consensus on industrial policies.[35] Such consultation appears to be a good way of enhancing the quality and success of the offices, as well as of other forms of interaction with business. But faculty members are not the only stakeholders in the future of the university. It may also be worthwhile extending this consultation to other stakeholders, inside and outside the university.

Integration into the National R&D System

Although world-class research is conducted in Canada, it produces only a small part of the world's R&D. It has been estimated for example, that Canada's share of the world's scientific papers in 1978 was 4.5 per cent.[36] Since no country can expect to be self-sufficient in its science and technology, many countries have sought to support or to develop mechanisms for technology transfer and diffusion. In general, industry is the main vehicle for transfer and diffusion, but Canada's industry is relatively weak in this regard.

How should the offices be integrated into the national R&D system?

A number of government programs have been aimed directly at structuring technology transfer services in Canada. As a result, there are many mechanisms now in place within universities, in industrial research institutes, and in offices for technology transfer. Other mechanisms are part of federal or provincial programs such as those of the National Research Council or of the Department of Regional Industrial Expansion, or of agencies, such as Ontario's IDEA, and the Centre de recherche industrielle du Québec, to name only a few. Some government initiatives such as the two industrial innovation centres operate independently. The private sector has consulting companies, patent agencies, and some brokerage agencies such as Biomedical Investment Opportunity Services Inc. (BIOS). The efficiency and effectiveness of all these mechanisms are not yet known.

How effective are the different mechanisms for technology transfer?

Since the mechanisms are so diverse and the harvesting of the fruits of university research and knowledge so important, cooperation among the many

How can the offices better cooperate with other technology transfer agents?

mechanisms is required. The National Research Council, concerned not to be perceived as a competitor by universities, is looking for ways to complement and assist the universities in their efforts to reap benefits from their research.[37] University offices for technology transfer are already working with other mechanisms for transfer. Universities are cooperating with each other, with federal and provincial bodies, and with local private resources such as business associations.

What role would the offices play in a national technology delivery strategy?

As well as cooperation, there is also a "need for a clarity and consistency of purpose on the part of all elements in a university's 'technology delivery' system."[38] Technology transfer is becoming a priority in the setting of Canada's science and technology policy agenda for the future. In recent federal-provincial meetings convened to develop a Canadian science and technology policy, the ministers have been concerned with accelerating the rate of diffusion of technology and technical information; they have recognized particularly the "importance of the transfer of technology from universities to industry and the need for greater cooperation between the two."[39] Through offices for technology transfer and participation in the framing of industrial policies, universities are influencing the national policy process.

Support

How should the offices be supported?

University offices for technology transfer need both financial support and the support of the university reward system. Thus far, the offices have been started mainly with seed money from the federal or provincial governments with the condition that

the offices become self-supporting. Both levels of government offer many financial aid programs. Some academics feel that government support, although helpful, has been erratic, ad hoc, and unreasonably limited.

Is there a need for better coordination of federal-provincial funding programs for the offices?

Some offices for technology transfer are becoming important components of their universities. As a legitimate part of the university, it would appear that an office ought not necessarily be required to be self-supporting.

To what extent should the university devote its resources to the support and development of the offices?

The university's reward system could better support the offices for technology transfer by offering incentives for faculty to engage in commercializing or applying their research. Compared with pure research activities, university-industry activities do not count for much in performance appraisals of faculty.

How can universities amend their reward systems to better support activities covered by the offices?

Location

At present, Canadian university offices for technology transfer exist at various levels in the university. The location of an office will depend to a certain extent on the institution's organization, culture, and traditions; therefore, what is an appropriate level at one university may not be at another. Nonetheless, there is some value in considering the various levels of current operations.

Where should the offices be located?

Only one office at a Canadian university (Toronto) operates at an independent level. An independent office minimizes its impact on university values or current functions, but its stance implies that commercializing activities are not a normal

Should the office be owned by the university but separate from it?

part of the functions of a university. Independence may turn out to be the office's greatest drawback. An important finding about technology transfer is that "the more a technology transfer system encourages direct communication between source and user in the choice of the knowledge to be transferred, the greater will be its success as seen by both sides."[40] Thus the success of an independent office may hinge, paradoxically, on its degree of dependence upon the university.

Should the office be located in the university's central administration?

Most offices in Canada have been established at the central administrative level. Proponents of this approach argue that centralized technology transfer offices are more clearly identified with the university and fit better into its overall management. Centralized offices can better inform industry of the amount and kinds of research being conducted throughout the university.[41] They can also provide industry with "one stop shopping" -- for advice, contacts, and research information.

Critics contend that centralized offices create additional bureaucracy and reduce the university's flexibility to respond to requests for research services. In larger universities, some faculty members have expressed concern about the seclusion of these central units; they consider them far removed from their own laboratories and from the interests and requirements of their industrial clients.

Ironically, some people in industry have commented unfavourably on the aggressive sales-oriented image of a few centralized offices. They are uncomfortable with an image that seems to represent the university's research efforts entirely as a business. These industrialists

would prefer that in their liaison with the university certain distinctions between the two sectors be maintained.

Some critics of centralization would rather decentralize all technology services, and have them at the faculty, department, or institute level. They claim that offices for technology transfer located at these levels seem to be more informed of the faculty members' research interests. They maintain that decentralization makes it easier to deal directly with research problems and to make industrial contacts.

Should the office be located at the faculty or department level?

Those in favour of centralization argue that it is difficult for those outside the university who are seeking to cooperate with university researchers to know where to make contact. They contend that problems in policymaking will arise when several offices for technology transfer in a university individually formulate or interpret university regulations and procedures. They also think that multiple offices are collectively more expensive to maintain, more difficult to coordinate (because of interfaculty politics for example), and duplicate the university's efforts in technology transfer. Too many offices could tip the balance of university activities in favour of achieving economic goals to the detriment of teaching and basic research.

The university comprises many faculties, each with its special functions. Medicine is one faculty in particular that has special requirements. Many faculties of medicine already have their own offices of research administration. Their problems with technology transfer, however, require close scrutiny by the university. Canadian biomedical

Do certain divisions of the university require their own offices for technology transfer?

researchers may have international reputations and industry may be particularly keen to do business with them. The pharmaceutical industry, for example, often has drugs tested by researchers at universities. Yet this activity is often neither reported nor fully paid for. Thus universities lose revenue. They are subsidizing R&D costs for drug companies, many of which are foreign-owned.

There is also an entrepreneurial role for offices for technology transfer in faculties of medicine. In Canada the industry for health care products is signally underdeveloped, and universities would do well to promote the transfer of innovations for development. Since university hospitals also play a role in research, they might collaborate with medical faculties to establish offices.

Functions and Structures

What should be the functions of the offices?

Current university offices for technology transfer collectively offer a wide range of services including patenting, licensing, and liaison. Some universities are also helping researchers to assess products, analyse markets, and develop business plans. Universities are providing equity for new spin-offs, establishing technology parks, and signing joint agreements with individual firms.[42]

How involved should universities be in the business end of the innovation process?

How should the offices be staffed?

Opinions differ on whether the offices are better served by business people, who understand technologies and can relate to academics, or by academics who have industrial know-how and contacts. There are various views on how offices should acquire the needed expertise. Some offices hire experts outright, others

contract out or use the services provided by public institutions. Several universities already have, or are establishing, special programs or research centres directly relevant to the functions of the offices, such as the New Venture Development Program (Calgary), the Centre d'aide aux petites et moyennes entreprises (Trois Rivières), and the Centre for High Technology Management (Carleton).

At present, it seems that offices for technology transfer almost always serve the needs of faculty in science and engineering and do so only at the research level. Aside from the implications this has for acceptance of the offices within the university, the offices' lack of involvement with the social sciences and humanities, and in teaching activities, represents lost opportunities for realizing the university's full economic potential. Transferring the expertise derived from such research and teaching could only improve the competitive position of firms in the private sector and enhance Canada's standard of living.

To what extent should an office use the technology transfer expertise available at its university?

Can the offices be extended to include the transfer of knowledge through training programs as well as the innovations produced in humanities and social science research?

Appendix 1. Profiles of Selected Offices for Technology Transfer

University of Alberta

Between 1981 and 1983 the board of governors at the University of Alberta enacted major administrative reforms to improve support for the research efforts of faculty and to promote the transfer of discoveries and innovations to industry and the community. The most important of these organizational changes was the establishment of an office of the vice-president for research in July 1981. This office administers the library, the university collections and archives, and a number of research centres and institutes in addition to grants, contracts, and technology transfer.

The university's commitment to research for industrial development is embodied in the unusual powers afforded the vice-president for research to become involved in commercial activities. He has the authority to organize the transfer of intellectual property developed within the university; he also represents the interests of the university on the governing boards of private companies in which it has equity and on those of certain public foundations.[1] The university had equity in nine companies as of November 1984.

The office of the vice-president for research has produced a number of policy initiatives to improve technology transfer to industry. It has drafted a new patent policy paper that will be referred to the university research policy committee for approval. It has also, through a standing committee of the vice-president for research, tabled a report on private companies, research consulting, and conflict of interest within the university. This document defines the boundaries and arrangements between faculty and private or university-owned commercial enterprises. The guidelines, although they protect the institution and its principal functions (teaching and research), also strongly encourage researchers to submit proposals to the office of the vice-president "for developing potentially viable commercial enterprises based upon research results at the university."[2]

A third policy initiative aims to generate a minimum of 50 technology transfer projects over the next five years. This goal, "Fifty in Five," has been adopted by the university. Research projects are expected in areas such as agriculture, forestry, electrical engineering, and pharmaceuticals.[3]

Possibly the most significant innovation in the area of technology transfer was the reorganization of the research grants and contracts office into an office of research services, in October 1982. The office of research services is part of the office of the vice-president for research. This restructuring was motivated by the desire to change the role of research administration from that of a passive intermediary between researchers and funding sources to that of an active promoter of research, inside and outside the university, which would attract new sources of funds and make the results of faculty efforts available for application and commercialization.

The creation of the office of research services coincided with a report of a commission on university purpose (April 1982). This report argued the need for a "research policy" and "an effective ongoing public relations program for research."[4] The commission also called on the university to generate more cooperative R&D arrangements with outside groups and to ensure that the community and industry benefited more from the university's research efforts.

With the appointment of a new director of the office of research services (recruited from industry) in 1983, technology transfer and community liaison became the central focus of the unit. Grant and contract administration were made the responsibility of an associate director. The director's

principal function is to initiate cooperative ventures between researchers and commercial or industrial enterprises.[5] He also plays a major role in setting up spin-off companies and in the university's assumption of equity positions in companies.

Three professional staff assist the director with these tasks: an industrial liaison officer seconded from the Alberta Department of Economic Development (for two to three days a week) and two technology development officers whose responsibilities include identifying and marketing commercially significant research on campus. One of these positions is funded by the National Research Council under a three-year PILP (program for industry/laboratory projects) grant awarded to the university in March 1985.

The reorganization of research administration at the university of Alberta has helped expand the research resources available for faculty. Between 1981 and 1984 research funding grew from $29 952 000 to $51 493 000. The university is currently involved in six companies based on technology transfer and will shortly start up two more. One of its spin-off companies deals with laser welding equipment for pipeline construction and shipbuilding. The university is also planning a joint venture with a local firm that manufactures industrial lasers for fabric cutting. The university, through the efforts of its vice-president for research, has been able to negotiate a one-third interest in this new company.

Notes

1. University of Alberta, Office of the Vice-President (Research), Triennial Report (Edmonton, 1984), 2.

2. University of Alberta, Standing Committee of the Vice-President (Research), Report of the Committee on Private Companies and Research Consulting Within the University, 1985: 7.

3. Valerie Shore, "At Alberta. Fifty in Five," University Affairs, 26, 7 (August-September 1985): 5-6.

4. University of Alberta, Senate, Report of the Commission on University Purpose (Edmonton, 1982), 42.

5. University of Alberta, Office of the Vice-President (Research) op. cit., 18.

University of British Columbia

At the University of British Columbia (UBC) research is administered by an associate vice-president for research, an office of research services, and a university executive committee of research responsible for policy advice and establishing links with the community. Both the office of research services and the executive committee report to the associate vice-president, a position created for the present incumbent in 1980.

UBC's office of research services is a long-established mechanism for encouraging technology transfer. Since 1968, the office's mandate has been to assist faculty with patenting, licensing, and contracting research.[1] In 1984, however, the university decided to take a more proactive approach to industry interaction. An industrial liaison officer was appointed to the office of research services to increase faculty awareness of industrial liaison and to act as a broker between faculty and firms interested in using UBC's research for commercial purposes.

Officials at UBC feel that the "development of industrial opportunities should be conducted as close as possible to faculty."[2] Their priority is to involve faculty in industrial liaison and technology transfer and to encourage researchers to forge links with the private sector. They consider that trying to stimulate the interest of industrialists in the university's research is a less effective way of promoting technology transfer. These views are clearly reflected in the activities of the new officer, who maintains a high academic profile (one quarter of his time is devoted to teaching) in addition to encouraging faculty to commercialize their research.

The decision to incorporate this new liaison function into the office of research services follows from UBC's singular approach to university administration. In terms of general operating expenditure, UBC ranks third among Canadian universities, but it ranks twenty-sixth in terms of spending on administration.[3] UBC prefers to operate a lean administrative structure that conveys to the outside world a strong collegial image. The creation of a separate office to handle industrial liaison might not fit in with the university's traditional management style.

In March 1985 UBC submitted a proposal to the B.C. government to develop its technology transfer and industrial liaison activities. This document reiterates, "as a matter of policy," UBC's commitment to "enhancing programs which encourage the private sector to collaborate with faculty members in research problems of mutual interest, thereby making research facilities and expertise available to the industrial community."[4] Technology transfer is given a broad definition that includes exchanges of graduates, faculty, and industrial researchers; support for collaborative research projects; patenting; licensing; and the establishment of spin-off companies to exploit university-owned and university-developed technology.

The proposal discloses some indicators of successful technology transfer: the office of research services is processing 17 patents and the university has set up five spin-off companies in as many years. The office of research services also signed licensing agreements with 10 firms during the 1984-85 academic year and negotiated 147 contracts worth over $2 million. In the coming years, the university aims to have industry contribute 20 per cent of all research funding. Part of this funding would come from 400 to 500 industrial agreements worth over $20 million a year.

In order to reach this goal, the UBC proposal to the B.C. government recommends that the government provide funding for five years to expand administrative services and faculty activities for technology transfer. The increased resources would be used to provide legal and technical assistance, information services, and to hire another industrial liaison officer. Funds are also required to buy faculty time for travel, to conduct feasibility studies, and to make contact with business people.

The recent Economic and Regional Development Agreement between B.C. and the federal government will provide financing to meet many of these needs (see Appendix 3). UBC has just hired a projects officer to assist the industrial liaison officer with patenting, licensing, and data processing. The officer will also be responsible for compiling a list of university experts in various areas and making it available to local firms.

Notes

1. P.A. Larkin, "Research at Universities in British Columbia Part 2: Some Administrative and Financial Considerations," a discussion paper (mimeo) prepared for the Universities Council of British Columbia, Vancouver, 1984.

2. R. Spratley, research administrator at the University of British Columbia, personal communication.

3. Canadian Association of University Business Officers, Financial Statistics of Universities and Colleges 1983-84 (Ottawa, 1985).

4. University of British Columbia, "Technology Transfer and Industrial Liaison at the University of British Columbia: A Proposal for Development," 1985, 1.

University of Calgary

In the summer of 1982, the president of the University of Calgary appointed a committee to study the benefits and concerns of technology transfer and to recommend "appropriate mechanisms whereby this activity could either be encouraged, or controlled, or both."[1] In its report, the committee identified strong faculty support for closer university-industry interaction and recommended a number of policy, procedural, and organizational reforms to improve relations between the two sectors.

The committee suggested a number of changes in consulting practices, overhead charges, and software development. Its central strategy, however, was to establish a gateway mechanism within the university to promote and assist the commercialization of faculty research, as well as to provide research services to local industry. This mechanism would be composed of a technology transfer office (reporting to the vice-president for research), a technology advisory board, and a technology transfer standing committee that would advise the vice-president on matters of policy.

The university executive has acted on a number of these proposals and is developing others. An office of technology transfer was established in February 1985 and is currently staffed by two professionals who are helping faculty market their inventions. The office also has a mandate to stimulate industrial demand for university R&D. Patents and contracts continue to be handled by the research services office, whose director works closely with the director of the unit for technology transfer.

The university decided not to implement the committee's recommendation to set up specialized advisory bodies for technology transfer. The university's research policy committee continues to advise the research services office and the office of technology transfer on industrial liaison. The university patents committee, however, will soon

be replaced by an intellectual property committee. The university intends to establish an arm's-length corporate entity to handle patents, licences, and joint ventures with industry. This new unit will be managed by a board of directors consisting of representatives from the university, industry, and local community.

In addition to these general measures, the University of Calgary has also reformed its computing services. An office of computing technology was established in 1984 with a mandate to transfer technology in this specialized area. Its director reports to the vice-president for research and the vice-president for priorities and planning. The office of computing technology manages three distinct units: academic computing services, super computing services, and the advanced computing technology centre. The latter two units are heavily involved with industry. The super computing services unit has a managing advisory board representing the spectrum of outside users who buy its services. The advanced computing technology centre develops software under contract using university expertise. Both are managed by the deputy director of the office of computing technology, who is also the general manager of industrial services.

Despite the short existence of technology transfer mechanisms at the University of Calgary, they appear to be having some positive results. The office of technology transfer is already overwhelmed with requests from faculty to help commercialize their inventions. The director has not had time to engage in outreach activities and will shortly be hiring a third professional staff member. The office of computing technology has declared a million-dollar profit on sales of software services by the advanced computing technology centre during the last fiscal year. A third of this money will be spent on setting up two new research centres in the natural sciences and in engineering.

Note

1. University of Calgary, Technology Transfer Committee, Expanding Horizons: Strategy for the Transfer of University Research and Innovation, (Calgary, 1983), 2.

University College of Cape Breton

The University College of Cape Breton arose out of the amalgamation in 1974 of the Sydney campus of St. Francis Xavier University and the Nova Scotia Eastern Institute of Technology. The university thus links two different traditions of postsecondary education: that of the liberal arts college and that of the technical institute. It aims not only to maintain both traditions, but also to provide a forum where each can make an impact on the other.

Its small size and lack of graduate programs challenge the university's ability to create and sustain an intellectual atmosphere of research and development. At the same time, the university's technical orientation combined with the pressing needs of the Cape Breton community provide a strong motivation to devote its research to meeting these needs.[1] The college's response to these challenges has been to establish a number of institutes, one of which is the Bras d'Or Institute,[2] set up in 1972.

The goal of the Bras d'Or Institute is to stimulate research, development, and enquiry relevant to Cape Breton Island. It is funded by the university, government programs, and contract work. The university's funds are used to pay the salary of the director and a secretary, to provide travel and office expenses, and to provide seed money for various projects. The director is appointed by and responsible to the president of the university. The institute is governed by a board of advisers, which decides policy, general programs, and priorities.

To achieve its goals, the Bras d'Or Institute:

1. promotes the development of faculty by involving them in community problems and by bringing in highly qualified personnel to work with faculty for short periods;
2. provides technical and administrative support for individuals or groups working on an area of development where such support may not be locally available;
3. undertakes research programs in areas in which the college staff have special skills and which meet the needs of the Cape Breton community;
4. when it does not have (or cannot develop) the necessary research expertise, brings problems to the attention of other individuals or organizations and encourages their participation in working toward solutions;
5. sponsors and organizes conferences, seminars, or workshops on topics of importance to the Cape Breton community; and
6. maintains and continues to build a collection of books, periodicals, and reports, for research on and development of Cape Breton.[3]

One of the institute's current projects is called "Innovations and Inventions." Its aim is to increase awareness in local industries of the need to continuously improve their technology. The program encourages innovation and invention, sponsors science and technology displays, provides patent information, and generally promotes activities to increase the scientific and technological sophistication of Cape Bretoners.

The Bras d'Or Institute has had considerable success in fulfilling the goals set for the university's institutes. Not only has it promoted research within the university, but it has also linked academic expertise to community needs. It has been instrumental in establishing such organizations as the Atlantic Coal Institute, New Dawn Enterprises, the Mira Community Pasture Cooperative, and the Cape Breton Fruit Tree Association.

Notes

1. D.F. Arseneau, "The Role of Institutes in Colleges," unpublished speech delivered at the Tenth Conference of College Chemistry Canada, Camosun College, Victoria, B.C., 3-5 June 1982.

2. For a list and description of some of these institutes see Paul H. Evans, University Research Institutes and Centres in Atlantic Canada with Regional Perspectives (Halifax: Council of Maritime Premiers, 1985).

3. Arseneau, op. cit.

Ecole Polytechnique

The Ecole Polytechnique is Canada's second largest engineering school. It offers courses to over 5000 students in a wide variety of engineering disciplines and fields. Of the faculty of about 220, most are actively involved in engineering research. Founded in 1873, the Ecole Polytechnique is an autonomous institution affiliated with the Université de Montréal. It awards degrees and is, in effect, Canada's best example of a technological university.

The Ecole Polytechnique established an office of research in 1970. A director of research (equivalent to a vice-president of research) was appointed, who set out to define a research strategy for the school. After months of consultation and planning with faculty, it was agreed that the school should:

- emphasize engineering and applied science research rather than pure research;
- focus on industrial and environmental problems rather than abstract subjects;
- be committed to strong and sustained liaison with industry;
- promote teamwork; and
- emphasize creativity, entrepreneurship, and technological innovation.

The school would focus its research on the following themes: industrial products and processes, energy, materials, structures, environment, mineral resources, biomedical engineering, information processing and telecommunications, and systems engineering.[1]

Following this agreement, the Ecole Polytechnique decided to establish a technology development centre to manage research contracts and promote links between faculty and industry. The director of the new centre reported to the director of research. Policy and planning decisions were assigned to a separate board made up of representatives from the Ecole Polytechnique, federal and provincial governments, and industry.

In 1984 the school decided to identify some new research priorities in response to directives emanating from the Quebec government's technology policy. The director of research supervised an internal consultative process whereby different departments were asked to define their research interests. This planning exercise produced faculty consensus on the need to devote extra resources to two research areas: computer engineering and materials engineering.[2] They also agreed to designate four other areas of special interest: biotechnology, electronics, transportation, and energy.

Shortly thereafter (December 1984), the executive council approved a plan to reorganize research administration at the school.

The director of research now oversees three offices that offer a variety of services to faculty for research and technology transfer. The grants office, managed by the associate director of research, links faculty with the granting agencies and foundations. The technology development centre, also known as the contracts office, has been given an expanded mandate that now includes negotiating and signing agreements with industry, patenting faculty research, and arranging licences for interested firms and investors.[3] Finally, a cooperative R&D office has been established to promote joint research projects between the school and industry. The director of this unit is actively involved in linking faculty research with interested industrial partners. The director also helps to formulate joint projects and to arrange third-party funding when this is available.

Two new internal research committees were set up following these reforms. The advisory committee on R&D comprises industry, university and government representatives. It advises the director of research on all matters pertaining to his mandate. The research management committee, on the other hand, reports to the director of research. Its function is to coordinate the services and activities of the three research offices.

These administrative reforms place the Ecole Polytechnique at the forefront of universities offering specialized services and mechanisms to help faculty to obtain research funding and to commercialize their research results. The reforms were institutionalized in response to internal and external demands requiring the school to focus its research efforts and transfer technology to the economy. In 1983 the 220 active researchers (staff and researchers) at the Ecole Polytechnique received 225 grants and negotiated 78 contracts that brought in a total of $8.5 million in external funding for its research.

Notes

1. Roger Blais, "Research Administration Revisited," SRA Journal of the Society of Research Administrators, 16, 4 (Spring 1985): 37-44.

2. Ecole Polytechnique, Préparer aujourd'hui les ingénieurs pour la société de demain: le projet de l'Ecole Polytechnique de Montréal (Montreal, 1984), 4-5.

3. Ecole Polytechnique, Centre de développement technologique, Rapport d'activité (Montreal, 1984), 7.

University of Guelph

In 1982 the University of Guelph adopted an industrial interaction strategy that recommended a number of policies, structures, and support services to help the university increase its contacts with industry. (A list of its recommendations appears in Appendix 4). To date all but the final one have been approved or implemented.

The strategy was developed to address concerns expressed by the university research board (a senate body responsible for research policy) about whether the university should develop more interactions with industrial companies, and if so, how they should be developed.[1] Contributing to this concern were Guelph's traditions as well as an awareness that external conditions were changing.

Because of its heritage as an agricultural college -- it still performs from 60 to 70 per cent of the research of the Ontario Ministry of Agriculture and Food -- Guelph was used to planning and had few inhibitions about producing a marketable product. Indeed, its research policies handbook stresses that the full spectrum of research, from fundamental through developmental, is appropriate as university research and, moreover, is "desirable for the creation of an appropriate environment for student learning, both undergraduate and graduate."[2] Furthermore, Guelph was and continues to be one of the most research-intensive universities in Canada. In addition, there was a sense that new external challenges were appearing in the forms of new technological needs of industry, projected shortages of scientists and engineers, and declining financial capabilities of universities.[3] These challenges were giving rise to a new emphasis within the university's functions.

> It is generally accepted that universities are very effective in their mission of scholarly research. They are also proficient in the dissemination of new discoveries throughout the scientific community. There is a growing requirement, however, that they must improve their effectiveness in <u>delivering</u> research results to the industrial agencies capable of applying those new technologies to better products and services useful to the public.[4]

All the above factors led to the establishment of a committee on industrial research, whose task was to examine how the university might respond to the perceived need to upgrade its services to industry. The result was Guelph's industrial interaction strategy (see Appendix 4).

The strategy recognizes the potential benefits of expanding the university's program of service to industry. It also acknowledges the risks. Guelph uses careful management to ensure that the university's scholarly teaching and research activities are strengthened and not undermined by increased industrial interaction. But management is not intended to be merely defensive; it also has to be proactive. In April 1983, in accordance with the strategy, an industrial services office was established within the university's office of research. It has two main aims: to commercialize the results of university research and to provide research services (consulting, service, and research contracts) to industry.

The office has a director, whose duties are outlined in the strategy's tenth recommendation, and has recently added a technology development officer. The officer, whose position was made possible by funding under an IDEA Corporation program, identifies technology for commercialization and advises faculty members. A third component in the industrial services network is now being planned. With seed funding from the Ontario Ministry of Industry, Trade and Technology, an innovation centre has been set up to focus on the marketplace and to be more entrepreneurial in the development of innovations.

Guelph focuses its marketing efforts on areas in which it already has expertise. Its marketing targets include the agricultural industry, agricultural suppliers, the food, drug and chemical industries, private consulting companies, and veterinary practitioners. These efforts are designed

to increase industrial revenues and enhance Guelph's technical reputation.[5]

In the fiscal year 1983-84, business and industry provided 5.6 per cent of the total $35.5 million generated by external research grants and contracts. Since the office of industrial services opened, there has been a 147.4 per cent increase in research funds received from business and industry.[6] The office has three patents, has another four under development, and has concluded three licensing agreements. Invention disclosures are growing at an increasing rate.

Notes

1. University of Guelph, Office of Research, The Industrial Interaction Strategy of the University of Guelph (Guelph, 1982), 2.

2. University of Guelph, Research Policies and Information Handbook (Guelph, November 1984), A1.

3. University of Guelph, Office of Research, op. cit., 8.

4. Ibid., 15.

5. Ibid., 14, 19.

6. University of Guelph, Office of Research, Research Grants and Contracts Awarded and Research Funds Received in 1984 (Guelph, n.d.), 109-110.

Université Laval

At Laval, an assistant vice-president responsible for academic affairs and research oversees a well-staffed office of research and coordinates the administrative services provided by 12 vice-deans for research (in the faculties) and eight research directors of university centres and institutes. A research committee formulates general research policy, sets priorities, and decides on internal budgetary allocations in research. Decisions flow easily through the system, which, despite its highly structured state, is both efficient and well-organized.

Laval has undertaken a number of strategies over the past four years to foster industrial liaison and technology transfer. Some of these are rather unusual. The university has identified research areas that are relevant to local industrial growth, initiated regional cooperative action for research, and signed an agreement with a government agency to provide services for the commercialization of faculty research.

In February 1984 Laval's executive council adopted a plan of action for the university. This declaration of policy recognizes Laval's commitment to play "a leading role" in focusing the economic recovery of metropolitan Quebec "on the use of high technology and the development of a research industry."[1] In accordance with its plan, the university aimed for a 20 per cent increase in research funding for 1986. A number of priority areas have been identified such as biotechnology, computer science, and management. The funding objective will be realized during the 1985-86 academic year.[2] The university has also allocated over a million dollars for the purchase of equipment for the computer centre.

On another front, Laval was one of the prime movers behind the formation of the Groupe d'action pour l'avancement technologique et industriel de la région de Québec (GATIQ) in 1983. Four other institutions[3] are members of GATIQ, whose goal is to support cooperative research and technology

transfer between industry and the research organizations located in Quebec City.[4] GATIQ'S first initiative was a proposal to set up a technology park in the region. The Quebec government recently passed legislation establishing this park. GATIQ aims to locate about 50 research institutions in the park by the year 2000.[5] Laval is represented on GATIQ by its president.

A third initiative to foster technology transfer is the 1979 agreement between Laval and the Centre de recherche industrielle du Québec (CRIQ). This established a jointly managed program (le Programme conjoint de valorisation industrielle de la recherche universitaire) whereby the government agency provides collaborative research support or commercial services or both to help transfer university research to the marketplace. The director of the office of research is the principal university administrator involved in this program.

In addition to these external initiatives, the university also provides internal support for technology transfer. The present director of the office of research was recruited from industry in 1976. His mandate is to facilitate technology transfer by providing contractual, patenting, and licensing services to faculty and carrying out liaison with local industry. The director is assisted by a contracts officer and an information officer. The office also includes two grants officers and two computer specialists.

Laval is currently restructuring its technology transfer services because of increased faculty interest in R&D contracts and in commercializing research. During 1984-85 the office of research processed some $6.5 million worth of industrial agreements. A proposal awaits approval from the executive council to establish an office of industrial research under the assistant vice-president for academic affairs and research. The university is also negotiating with the National Research Council to have an NRC field representative locate on campus and be responsible for linking Laval faculty with local industry. It is expected that the NRC expert will work closely with administrators appointed to the new industrial research office.

Notes

1. Université Laval, A Commitment to Quality: Building on our Strengths, A Plan of Action for Laval University, (Quebec City, 1984.), 4.

2. "Laval Achieving Objectives Ahead of Schedule," University Affairs, 25, 10 (December 1984): 9.

3. Institut national de la recherche scientifique, Centre de recherche industrielle du Québec, La Chambre de commerce et d'industrie du Québec métropolitain, and the Société Inter-Port de Québec.

4. Groupe d'action pour l'avancement technologique et industriel de la région du Québec, Carrefour de haut savoir, de recherche et de transfert technologique (Quebec City, 1984).

5. Linda Châteauneuf, "L'Université Laval en plein essor," Affaires Universitaires, 26, 8 (October 1985): 10-11.

University of Manitoba

Research at the University of Manitoba was administered until 1980 by the faculty of graduate studies. It was augmented by a separate office of industrial research (OIR), which had been established in 1971 under the industrial research institute program of the Department of Industry, Trade and Commerce. In 1980 two major steps were taken to highlight and facilitate the research function. The university created the position of provost for research (in 1982 revised to associate vice-president) reporting to the vice-president (academic) and established a central office of research administration. This office combined the contract skills of the OIR (phased out in 1985) with the experience of research grant management and introduced a strong thrust in research promotion. In the first five years of operation of the central office, external income for research and special projects at the University of Manitoba increased from $24 million to $50 million. Contract research represents 15-20 per cent of this external income. The office has also taken a proactive stance in the patenting and licensing of innovations with advice from an external patent agent and the university's on-site legal counsel.

The policies and practices related to research are monitored and reviewed by a university research committee of senate, which in 1983 replaced a long-standing research board. The university research committee, which has representation from deans, faculty researchers, and students and is chaired by the vice-president (academic), advises the senate of the university and the central administration.[1] The distribution of funds made available for the internal support of research is delegated to a research grants committee chaired by the associate vice-president (research) and administered by the office of research administration.

The University of Manitoba has developed through the consultative process an academic plan, which was published in March 1984, together with a series of statements of intended action related to strategic and tactical matters.[2] This document addresses the pressures on universities to become more service oriented and recognizes the opportunity for the university to contribute to product and technology development by cooperating with government and industry. In so doing it cautions against contract research and development work that would detract from the university's primary mandate. The plan reaffirms the fundamental commitment of universities to the generation and communication of knowledge, and stresses the need for universities to recognize that many of the fundamental aspects of their work can be expressed and pursued in ways that contribute to the solution of social problems.

Individual faculties have taken special initiatives to obtain direction and support from the private sector. The faculty of adminstrative studies has formed an influential group of associates limited in membership to 200 senior executives. In 1977-78 the dean of engineering set up a faculty-industry liaison committee "to provide moral and advisory support to the faculty who are expected to take the initiative, establish and expand industrial contacts and provide leadership and support to Manitoba industry."[3] The structure of this committee is novel. It is formed of faculty members and business people who also sit on separate advisory committees in each department. Each advisory committee is chaired by a representative from industry. These committees have been instrumental in developing two new and industrially relevant faculty programs, industrial engineering and computer engineering, as well as giving advise on research directions.

Although the university still lacks a central office for technology transfer, it is taking increasing advantage of the interface programs available from provincial and federal agencies. In 1985 the National Research Council set up an industrial technology advisory office on the campus. The IRAP officer in charge has a specific

mandate to encourage and support links between faculty and business people.

Links are also strengthened by the participation of university members on government and industrial boards. Since 1982, the associate vice-president (research) of the university has chaired the Manitoba Research Council, a 15-member advisory body to the provincial minister of Industry, Trade and Technology.

Notes

1. University of Manitoba, Research Guide of the University Research Committee of Senate (Winnipeg, 1985).

2. University of Manitoba, Report of the Presidential Task Force on an Academic Plan for the University of Manitoba, 1984, 3, 8, 23, 24.

3. "Special Meeting of Engineering Deans and Heads with Chairman of Faculty-Industry Liaison Committee Chairmen," minutes, 29 September 1980, 1.

McGill University

At McGill, the offices of the vice-principal of research and of the dean of graduate studies and research, are held by the same individual. That person is therefore responsible for research administration, research policy, and relations with various government agencies, as well as for the activities of the faculty of graduate studies and research. Combining the two positions is intended to ensure that research is well-integrated into the daily life of the university.

The current vice-principal supports the idea that McGill should take an active part in trying to relate its research more closely to the welfare of society.[1] Apparently there has been a corresponding awakening of interest on the part of many faculty members. Consequently, despite a belief at McGill that the administration of research should simply be a coordinating effort not requiring a large central bureaucracy, there has been an institutionalizing of the university-industry interface. Although it has been difficult to obtain funds, a fairly extensive organization to support technology transfer has been set up.

The chief agent of McGill's research outreach activities is IR McGill (the office of industrial research). It does not conduct research itself, but is a service office for McGill and the external community. IR McGill was set up in August 1971 "to foster and catalyze the interaction between McGill faculty and private industry, government or other non-profit organizations for the purpose of establishing contractual agreements in research and development."[2] Initially it received a grant from the Industrial Research Institute Program of the federal Department of Industry, Trade and Commerce; however, within four years -- and within less time than any comparable institute[3] -- the office became self-supporting.

At the beginning of 1984 another service function, the handling of inventions and patents, was added. IR McGill now consists

of two offices: the research contracts office and the inventions and patents office. Besides these two functions, IR McGill also helps to establish cooperative research activities between industry, McGill, and government.

The director of IR McGill coordinates its two constituent offices. A major function of the director is to ensure that academic values prevail in all of the complex interactions of that office with outside groups.[4] Hence, the director maintains an academic position on a part-time basis. The current incumbent is also associate dean of graduate studies and research in the faculty of medicine and a professor of pharmacology.

The research contracts office is responsible for all research contracts, but does not handle service or consulting contracts. The contracts officer is responsible for checking all proposals for research contracts to ensure that they are in harmony with the university's research policies. The contracts officer is also required to obtain a detailed understanding of a client's problem, assemble faculty members with the needed skills and experience, help work out a detailed plan of action, and be responsible for the post-award administration of the contract.[5]

The volume of contracts has risen from 23 in 1971 to more than 100 in 1984. In the same period, the average value of a contract has increased from $6500 to over $50 000. The current value of contracts is more than $6 million; 30 per cent of this money comes from industry.[6] (The total value of research funding, including grants, contracts, and fellowships, at McGill in 1984-85 was $78.9 million). Overheads are charged on contracts; a 50 per cent overhead is charged to industry. Overheads are distributed according to a decision of McGill's board of governors. After up-front costs for IR McGill have been paid, 50 per cent of the remainder goes toward the general expenses of running the university, 25 per cent is used for research graduate fellowships in all fields (this is the only source of unrestricted funds for this purpose at McGill), and the remaining 25 per cent is allocated to departments, in proportion to their contract research activity, for spending on research priorities.[7]

The purpose of the inventions and patents office is "to catalyse technology transfer and commercialization of McGill's most promising inventions, and to assist entrepreneurial researchers in interacting with industry through grants, patenting, licensing, and other mutually advantageous arrangements."[8] When the office receives a formal report of an invention, it ensures that the following tasks are performed: evaluation of the uniqueness and usefulness of the invention, analysis of its technological and commercial feasibility, identification of and contact with potential licencees, consultation with and presentation to the patent committee, protection of the invention, and preparation of a licence agreement.[9] In carrying out these tasks the office works with other agencies involved in technology transfer, for example, the federally sponsored Centre d'innovation industrielle de Montréal or the provincial Centre de recherche industrielle du Québec.

Before the establishment of the inventions and patents office, McGill made little effort to commercialize inventions and the income from them was negligible. This situation has now changed dramatically. The office is currently handling 40 inventions, has filed for 10 patents, and established three licences. Twice as much income ($30 000) was derived from these sources after the office's first year than in the previous 20 years. Because of this response, the director of the office feels a need for firmer financing for the office and for specialist assistance.

Besides IR McGill, another vehicle for closer interaction between McGill and industry is the office of biotechnology. Its director holds the endowed Canadian Pacific chair in biotechnology, the first of its kind in Canada. This office's purpose is information transfer. It maintains a database on biotechnology activities at McGill, provides information on outside biotechnology groups,

arranges meetings and seminars, and organizes and promotes biotechnology within McGill and in the community. The office has an aggressive outreach program, directed especially at small, high-tech companies in Quebec. The director would like to be able to hire someone to investigate products that are potentially marketable to industry.

Notes

1. Gordon Maclachlan, Faculty of Graduate Studies and Research Newsletter, (McGill University, October 1984), 3. See also his paper, "The Ivory Tower is Leaning Towards Industry," unpublished speech delivered at the 23rd annual conference of the Canadian Research Management Association, September 1985, Jasper, Alberta.

2. McGill University, IR McGill: Offices of Industrial Research, (Montreal, 1985), 1.

3. Sidney I. Featherman, An Examination of Programs for Technology Transfer: Industrial Research Institutes and Centres of Advanced Technology (Ottawa: Department of Industry, Trade and Commerce, 1980), 11.

4. Gordon Maclachlan, "New Outlook for Offices of McGill International and Industrial Research, McGill," announcement, McGill University, Montreal, 16 April 1984.

5. McGill University, op. cit., 2.

6. Ibid.

7. Gordon Maclachlan, "Goals and Aims of Offices of Graduate Faculty Dealing with Research," interdepartmental memorandum, McGill University, Montreal, 14 November 1984, 3.

8. McGill University, op. cit., 1.

9. Ibid., 10.

Université du Québec

Established in 1968, the Université du Québec is made up of 11 institutions located in seven cities across Quebec.[1] The degree-granting universities, schools, and institutes are considered to be both autonomous and interdependent.[2] They have their own corporate charters and administrative structures. They formulate their own research plans (triennial, biannual, etc.), which, however, must be coordinated with those of other institutions in the network and approved by the university senate and board of governors.

A central administration in Quebec City manages this process. The vice-president responsible for academic affairs and research chairs a research and teaching committee made up of vice-rectors responsible for academic affairs and research from constituent universities and research directors from the institutes and schools. The vice-president also oversees a central office of research services whose director coordinates the activities of similar offices located elsewhere in the system.

Each institution is responsible for meeting the educational and research needs of its local community and for liaison with industry. Four institutions have established mechanisms to facilitate links with firms, and the university is currently debating a plan to develop these liaison units further and to create new ones in the network.

The Institut Armand-Frappier teaches graduate students in medicine, conducts basic and applied medical research, provides medical services and produces vaccines and diagnostic kits.[3] A director responsible for commercializing research manages production units and a commercial division. He sits on a research committee, chaired by the director of the institute, in which the industrial activities of this multifaceted and immensely successful institute are proposed and agreed upon. The committee is composed of faculty and business people.

The Institut national de la recherche scientifique (INRS) consists of eight research centres that conduct research in particular areas such as water, health, and telecommunications.[4] In general, each centre establishes its own links with industry, such as the well-known teaching and research agreement between INRS-Télécommunications and Bell-Northern Research. The research activities of INRS are coordinated by a powerful scientific committee made up of a scientific director (chairperson) and representatives from government and industry.

The Université du Québec à Chicoutimi created a technological innovation office to promote the research needs of industry within the university. This non-profit corporation is managed by a board of directors made up of faculty and local business people.

The Université du Québec à Montréal (UQAM) has a technology development officer who reports to the vice-rector of communications. This officer is responsible for promoting faculty liaison with industry, helping faculty to commercialize their research, and negotiating cooperative agreements between the university and private firms. Other industrial services provided by UQAM are handled by an efficient office of research services, which has just been reorganized and given the name "Le Service de la recherche et de la création."[5]

The Université du Québec hopes to expand these mechanisms and services as soon as adequate financing can be secured. An internal document outlines plans to create eight offices of information and university-industry collaboration. These units would have a mandate to promote faculty expertise in the business sector and to help faculty identify and work on industrial R&D problems of interest to them and their students. It is expected that the new liaison mechanisms will build upon existing services and forge strong links with specialized government institutions for technology transfer such as the Centre de recherche industrielle du Québec and the Centre d'innovation industrielle/Montréal.

Notes

1. Université du Québec à Montréal, à Trois-Rivières, à Chicoutimi, à Rimouski, à Hull, en Abitibi-Témiscamingue; Ecole nationale d'administration publique; Ecole de technologie supérieure; Institut Armand-Frappier; Institut national de la recherche scientifique; Télé-université.

2. Université du Québec, Schéma général de développement (Quebec, 1980), 14.

3. Université du Québec, Institut Armand-Frappier, Rapport Biennal 1982-84 (Laval, 1984), 1.

4. INRS-Eau, -Education, -Energie, -Géores-sources, -Océanologie, -Santé, -Télécom-munications, -Urbanisation. Université du Québec, Institut national de la recherche scientifique, Rapport annuel 1983-84 (Ste-Foy, 1984), 2-3.

5. Université du Québec à Montréal, Politique d'organisation et de financement de la recherche et de la création à l'UQAM (Montreal, 1985).

Queen's University

Queen's University established the Canadian Enterprise/Innovation Centre in 1985. Prior to this, the university had developed mechanisms to patent its technology. It was one of the first universities in Canada to employ an in-house registered patent agent, which it did in 1975.[1] Queen's was also the first university to sign an agreement with IDEA Corporation under the latter's commercial development officer program. The funds from IDEA Corporation were combined with those from a program sponsored by Ontario's Ministry of Industry, Trade and Technology to form the centre.

The Canadian Enterprise/Innovation Centre comprises an executive director, a commercial development officer and a director of patents and licensing. The executive director's role is as a "catalyst to help various groups come together and create teams which can use university and industry resources."[2] The centre is not restricted to the university community at Queen's. It cooperates with Trent University and two community colleges, St. Lawrence College and Loyalist College. In addition, a Kingston group of retired business people, the Enterprise Resources Committee, provides a source of business expertise and advice for the centre. Although the centre is part of Queen's University, the plan is to have it become self-sufficient and independent.

Unlike most other university offices of technology transfer, the Canadian Enterprise/Innovation Centre is not part of an office of research services, but comes directly under the vice-principal for institutional relations. Nevertheless, it maintains close ties with the research services office. The centre used to be linked to the university's inventions and negotiating committees. The former committee assessed patentable inventions, and the latter worked out the details of licensing with companies. The exact process of technology transfer, however, is now being modified to increase its usefulness to university researchers.

The value of industrial contracts has been increasing, since 1979-80 when they amounted to $598 000. In 1983-84 Queen's received $27 228 000 in external research funding. Of that, $1 837 000 came from industry, mostly in the form of contracts.

Notes

1. Nancy Dorrance, "University-Industry Links: '21 productive meetings in my first 2 weeks'," Queen's Gazette 17, 28 (October 1985): 291.

2. Ibid.

Ryerson Polytechnical Institute

Ryerson is committed to providing professionally relevant education. Consequently, it emphasizes career-oriented learning and maintains extensive links with its community. In 1982 a centre for industrial development (CID) was established as an administrative unit of the institute. The centre's director is accountable to Ryerson's vice-president for academic affairs. An executive committee, composed of individuals from industry and government, reviews the centre's activities and assists in developing its policy.

The CID's objectives are:

1. to coordinate, develop, and implement industry-based research projects that focus on product development, product testing, quality control, and productivity improvement;
2. to ensure that an ever-increasing number of students develop research skills that are immediately applicable to industry;
3. to facilitate the application of the latest technologies to a variety of different industries;
4. to assist in managerial and technological implementation of productivity improvements in collaboration with industry, and to ensure that students are exposed both to managerial and technological methods of assessing ways to improve productivity.[1]

The chief activity of the centre is "to marry the expertise existing at Ryerson with the needs of both the private and public sectors -- particularly the small, young companies that cannot yet afford to support engineers and research staffs."[2] The CID also manages Ryerson's patent policy, is involved in electronic publishing and Ryerson-generated business products, and generally acts as the research office for the institute.

The centre was formed with financial support from the then Ontario Ministry of Industry and Trade, which provided the centre with $300 000 during the first three years. By its fourth year (1984-85), the centre had become self-supporting, in part because it had decided to further develop its business activities and to pinpoint a few key areas in which to invest resources. In 1984-85, the CID assessed approximately 150 projects requesting assistance, approving one in three to begin immediately. (A third of the projects submitted were initiated by Ryerson faculty, students, or staff members.) In the same year, 21 projects were initiated and another 18 continued with external funding. The retained earnings per project averaged $1000, which amounts to a 20 per cent return on a contract price.[3]

To better support the development of entrepreneurial activities, an innovation centre was set up within the CID in 1985, with the assistance of the Ontario Ministry of Industry, Trade and Technology. Its objectives are "to guide and assist entrepreneurs in the development of their innovative ideas through to the start-up of a new enterprise," and "through a blend of technical and business advice and assistance, to stimulate technology transfer and innovation within existing firms so that they develop and/or maintain a competitive position in their respective markets."[4] The innovation centre's project load for the first six months is already greater than anticipated. Additional seed funding had to be provided out of the CID reserve.

Notes

1. Ryerson Polytechnical Institute, Centre for Industrial Development, Annual Review (Toronto, 1985), 4.
2. Ibid., 2.
3. Ibid., 8.
4. Ryerson Polytechnical Institute, Centre for Industrial Development, Ryerson Innovation Centre, Summary Description (Toronto, 1985), 1.

Simon Fraser University

In April 1984, the office of the associate academic vice-president established a research investment task force to determine faculty interest in industrial liaison and to advise on strategies and mechanisms. An internal survey (420 questionnaires and 85 interviews) revealed that "a great majority of faculty from nearly all departments wanted the university to be more aggressive in developing interaction with the private sector."[1] Those responding to the survey also felt that "the establishment of an office specifically concerned with the promotion and marketing of the expertise of faculty" was essential to the expansion of the university's interaction with the private sector and government agencies.[2] They viewed the newly created office of vice-president for research and information as the most likely focal point for pursuing this matter.

The university established the research and information office in 1984 while the task force was conducting its study of faculty interests. The new administrative unit (which replaced the office of associate vice-president) was made responsible for research administration, the library, and the new computing centre. In addition to these duties, the task force recommended that the new office develop "a strategy for marketing SFU expertise in the private sector" and "a set of guidelines for invention incubation in the university which will encourage this activity and protect the university's interests."[3]

Budget cuts have delayed the full implementation of these recommendations.[4] The research and information office began operating in the spring of 1985 staffed by the vice-president and an executive assistant. It administers grants, contracts, patents, and licences. An industrial technology adviser from the National Research Council is located on campus in what is referred to as the SFU/NRC office. This individual promotes linkage between faculty and local businesspeople. A new program, the New Enterprise Program (handled by the faculty of business administration), is also available to help faculty apply business start-up and management skills to commercializing their research.[5]

Recent events indicate that the research and information office will be provided with more resources to promote technology transfer and industrial liaison. On 7 October 1985, the B.C. and federal governments (under the Economic and Regional Development Agreement) announced their intention to provide first-year funding for "university/industry liaison offices" at each of B.C.'s three universities. At Simon Fraser this money will be used to appoint a liaison officer to the research and information office. The vice-president for research and information systems also expects to appoint three faculty liaison officers to his unit in December 1985. These appointments amount to three one-third time positions, which have been guaranteed internal funds by the university. It is expected that these positions will be staffed by three leading researchers from the science, applied science, and social sciences faculties, who will engage in liaison activities with industry.

Notes

1. Simon Fraser University, Research Investment Task Force, "University-Private Sector Interaction," 1984, 1.

2. Ibid., 11.

3. Ibid., 11.

4. "$2-Million Savings Proposed by Head of Simon Fraser U," Chronicle of Higher Education 29, 11 (7 November 1984): 37.

5. The "New Enterprise Program for Technical Innovators and Enterpreneurs" is offered by the business faculty in cooperation with the B.C. Ministry of Universities, Science and Communications, and the B.C. Ministry of Industry and Small Business Development.

University of Toronto

The key offices dealing with research within the university's central administration are the vice-president for research and government relations, the research board, and the office of research administration.

The research board advises the vice-president for research and government relations and generally represents university research. The board was reformed in 1984 to give research a high profile within the university and to involve it more in internal policy and external research advocacy. The research board is now composed primarily of active researchers. Its mandate includes: formulating advice for the vice-president on matters relating to university research policies, research administration, research advocacy, institutional research strategies, publicity for university research, and liaison with research sponsors; serving as a policy and procedures board to the office of research administration; organizing and conducting internal grant application reviews; setting priorities or reviewing research proposals when required; awarding or advising on the awarding of internal research grants or contingency funds; assisting in research advocacy; and helping assess major research proposals to external agencies and helping with associated site visits.[1]

One of the research board's responsibilities is to administer the university's inventions and copyright policies. It does this through an inventions committee. The committee advises faculty on inventions policy and procedure, determines the extent of the university's legal interest in an invention, and is otherwise concerned with the system for processing inventions.[2] Under the terms of the university's inventions policy, any invention made using university facilities or funds belongs both to the inventor and the university. Inventions are presented to the inventions committee, which decides whether the university wishes to have inventor's rights (if it does, the inventor is entitled to 50 per cent of the revenue received by the university). Inventions in which the university is interested are referred to the Innovations Foundation for commercial and technical appraisal.

In keeping with the belief that "the commercialization of University research should be an enterprise as separate as possible from the normal operations of the University,"[3] the Innovations Foundation was incorporated in 1980 as a separate but fully owned corporate entity of the university. It is the university's primary vehicle for encouraging, promoting, and implementing "the commercial development and use of the results of the University's research laboratories."[4] In fulfilling this function, the foundation is constantly in contact with the university community, industry, and the sources of financial assistance. Once a decision is made to exploit an invention commercially, the foundation seeks out the most suitable companies for licensing and maintains an association with the licencee. When the interests of both the university and the inventor are best served by setting up new companies to develop inventions commercially, the foundation assembles the necessary entrepreneurial and management skills and arranges financing.[5]

Under an IDEA Corporation program, the Innovations Foundation received funding in 1985 to create an experimental seed-finance fund, the "Varsity Seed Fund." Funding for that first year amounted to $100 000 for investigating the commercial potential of some of the university's research: assessing the commercial viability of an invention, developing business plans for a new company or a new market, finding critical technical development work, or registering patents.[6]

The foundation, which is now funded by the university, is intended to become self-supporting. Income is increasing substantially from year to year and royalties are now generating $250 000. Some 300 inventions have been examined. Serious consideration was given to 211, of which 81 are being

patented, 86 are being or are already licensed, and the remaining 44 are inactive. There are 33 licence agreements. One company has been started up; a second is being planned. The foundation is also a major shareholder in a company based on university technology.

Notes

1. University of Toronto, Office of the Vice-President (Research and Government Relations), "Draft Procedures and Terms of Reference for the New Research Board," 19 September 1984.

2. University of Toronto, "Inventions Policy and Procedures," 9 December 1983.

3. University of Toronto, "Excellence and Diversity: The University of Toronto's Submission to the Commission on the Future Development of the Universities of Ontario," 20 August 1984.

4. University of Toronto, Innovations Foundation, Innovations Foundation University of Toronto, brochure, n.d.

5. Ibid.

6. IDEA Corporation, "Funds to help University inventions find commercial markets," The Innovators 2:2 (August 1985): 4.

University of Waterloo

Since its beginning in 1957, the University of Waterloo has been committed to cooperating with industry.[1] Perhaps the best-known expression of this is its cooperative education program. Waterloo is also committed to commercially-oriented research, and encourages interaction between members of the university and the wider community. The activities of the university have directly contributed to the setting up of more than 50 new companies and have attracted some major businesses to the Kitchener-Waterloo area. In 1983-84, $5.5 million of the university's total research income of $24.3 million came from contracts; about half that amount came from industry.[2]

Waterloo has sought to encourage the transfer of its research to the marketplace through various policies -- software, extra-university activities, and a patent policy that gives the inventor complete ownership of the patent rights -- and by providing services to help the contracting and commercialization of research. One notable example of the latter service is the Canadian Industrial Innovation Centre/Waterloo (CIIC/W), one of two such centres in Canada. The university, anxious to have its inventions exploited, set up an inventor's assistance program with help from the federal government. In 1979 the program was integrated into the autonomous CIIC/W, itself established by the university with federal financial assistance. The CIIC/W works with innovators from across Canada to "evaluate the market potential of new ideas and products, provide access to research and testing facilities for new product development, build business plans to take the innovations to market, coordinate financial assistance as required, assist in all facets of product marketing and enable innovators to manage the on-going development of their product."[3]

Research at Waterloo is administered through an office of research. Since 1981 the university has stressed the centralized administration of its total research function. The office of research handles

contractual, legal, and financial matters as well as dealing with external agencies, proposal development, and consulting. It is one of the few research administrations at a Canadian university that does not have to work through the university financial administration or business office. Administrators at Waterloo believe that this arrangement has improved the university's ability to cope with the changed research environment of the 1980s.

The basic responsibility of the office of research is to "assist in furthering the research capability of the University." It carries out a wide range of duties relating to the administration of research. For example, it negotiates and administers contracts, maintains effective liaison with clients, ensures that research proposals accord with university policies, and assists in technology transfer to industry, including the promotion of joint research efforts.[4]

The office of research is headed by a dean of research. Part of the dean's time is spent in serving on the Municipal Economics and Business Development Committee. The vice-president for academic affairs recently established a university council on research, prompted by the increasingly complex research environment and university underfunding. Among other duties, the council will advise the dean of research and provide an academic perspective and influence to the operations of the office of research. Reporting to the dean is a director of research services and development, who is responsible for the operation of the office and for fostering research. Since December 1983, the director has also been responsible for developing and implementing the university's research technology park.

Also reporting to the dean of research is the new commercial development office. It originated from the university's wish to be more actively involved in commercial development, and was made possible by funding from IDEA Corporation. The commercial development officer plans to be involved in patenting, licensing, and marketing but is currently focusing on spin-off firms and business start-ups. The officer has helped launch about six businesses since being appointed in March 1985.

The Waterloo Research Institute (WRI) is an integral part of the office of research. It was established in 1967 with help from the industrial research institute program of the federal Department of Industry, Trade and Commerce. WRI provides research and development services, under contract, to industrial and government clients. Its functions include:

1. helping clients and researchers to prepare proposals;
2. negotiating contracts on behalf of the university;
3. ensuring that contractual commitments are met; and,
4. providing administrative services during the term of the contract.[5]

Initially contracts officers went directly to various firms to attract business to WRI; however, most of their early contacts resulted from the consulting work of individual faculty members. Now firms tend to come straight to the WRI or are referred there by other firms.

The WRI administers a number of the university's specialized research centres or institutes, including the Institute for Computer Research and the Waterloo Centre for Process Development. These two organizations have interesting mechanisms for fostering university-industry relations.

Formed in 1982, the Institute for Computer Research brings together in a single organization several of the computer research groups on campus that have been highly successful in mission-oriented projects. Aside from promoting cooperation among the groups and allowing better use of facilities, staff, and services, the institute makes possible certain forms of cooperation with industry. An affiliates program in computer technology promotes contact with industry and government and facilitates the flow of information. A visiting professionals program supports

campus visits by employees of affiliates "for industrial sabbaticals, for intensive research cooperation, or simply to exchange ideas." A corporate partner program provides the benefits of the other two programs, as well as a private office in the institute. In addition, corporate partners are members of the institute's research advisory board.[6]

The Waterloo Centre for Process Development (WCPD) is one of the more interesting and successful models for effective technology transfer. It operates within the chemical engineering department and is run by an executive director. A board of directors, composed of individuals from industry, the university, and the federal government, sets policy and evaluates funding decisions. The centre began in 1978 with funding of $1 million spread over five years from the federal Department of Industry, Trade and Commerce. It is now self-sufficient. The WCPD provides a businesslike environment in a traditional academic setting and a focus for faculty to express and fulfil entrepreneurial initiatives. It also, thereby, provides alternative role models for students.[7]

The WCPD follows four basic strategies:

1. it identifies promising basic research ideas developed within the university and funds them beyond traditional bench-scale limits to the pilot plant or demonstration levels;
2. it licenses demonstrated technology to industry to allow full commercialization and to establish a funding base of royalty revenues for the centre;
3. it uses co-op and graduate students to supplement professional staff in some projects, thereby providing experienced personnel who can be employed on a client's project after graduation; and,
4. it actively attracts industry- and government-sponsored mission-oriented research contracts; these provide a window on the marketplace to help identify opportunities and focus project activity.[8]

The WCPD has attracted about $2 million in contract research, 60 per cent of which is sponsored by industry and the rest by government. The centre charges industrial contracts 100 per cent overhead. Since 1981 it has been involved in the issuing of 34 patents for chemical engineering professors. The centre currently administers eight international licences that will provide $500 000 in technology transfer fees and $5 million to $7 million in royalties over the normal life of the licences. These fees are recycled to fund promising research; about $500 000 a year is invested in chemical engineering at Waterloo. The WCPD pays its own way and operates as an accountable entity within the university. Space is rented from the university, and 10 per cent of all royalty income and 55 per cent of all the indirect costs associated with contract research activity are paid to the university. Last year these payments totalled over $300 000.

Notes

1. D.T. Wright, "The Canadian Experience in University/Industry Partnerships," in Technological Innovation: University Roles, Proceedings of the Thirteenth Congress of the Universities of the Commonwealth, Birmingham, August 1983 (London: Association of Commonwealth Universities, 1984), 196-204. See also University of Waterloo, Senate Long Range Planning Committee, Planning for the Third Decade (Waterloo, 1979), 28-30.

2. University of Waterloo, Office of Research, "Sponsored Research Funds: Statistical Data for Grants and Contracts," 7 May 1984, 6a.

3. Canadian Industrial Innovation Centre/ Waterloo, Helping Innovators, pamphlet, n.d.

4. University of Waterloo, Office of Research, "Basic Responsibilities of the Office of Research," 20 September 1983.

5. University of Waterloo, Services for Business, Industry and Community Organizations (Waterloo, January 1985), 12-13.

6. University of Waterloo, Institute of Computer Research, The University of Waterloo Affiliates Program in Computer Technology (Waterloo, October 1983).

7. E.B. Cross, "Technology Transfer at the University of Waterloo," unpublished speech delivered at the Financial Post Conference "Hi-Tech West," Vancouver, 27 March 1984, 6-7.

8. University of Waterloo, Waterloo Centre for Process Development, The Waterloo Centre for Process Development: Industry's Partner for Successful Technology Transfer (Waterloo, n.d.), 4.

Appendix 2. Ontario Ministry of Industry, Trade and Technology: Innovation Centres at Universities*

Centre	Focus
Innovation North Lakehead and Laurentian Universities	To provide bilingual evaluation and advisory services on marketing approaches, and business plan development. Lakehead will focus on forestry and pulp and paper, Laurentian on mining and mineral exploration.
Canadian Enterprise/Innovation Centre Queen's University	Technology transfer and outreach programs as well as development of a venture capital fund.
Ryerson Innovation Centre Ryerson Polytechnical Institute	Technical services, prototype development, business services, provision of "pre-incubation" space.
Innovation Centre Seneca College and University of Toronto	Cooperative project offering services in entrepreneur, product, and enterprise development.
Innovation Centre University of Guelph	Business advice, counselling, technical and research support needs and services. Marketing University technology and innovation.
Innovation Centre University of Ottawa	Technology transfer.
Innovation Centre University of Western Ontario	Statistically based quality control methods.
Innovation Centre University of Windsor	Business/management and engineering services.
Innovation York York University	Encouraging links between York's research strengths and industrial development in the private sector. University lab space for rent to pursue R&D activities.

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* Centres have also been established at the following colleges: Canadore (North Bay), Centennial (Scarborough), Durham (Oshawa), George Brown (Toronto), Georgian (Barrie), Humber (Rexdale), Niagara (Welland), Northern (South Porcupine), Sault (Sault Ste-Marie), Sheridan (Oakville), and Sir Sandford Fleming (Peterborough).

Appendix 3. University-Industry Liaison Offices in the Canada-British Columbia Subsidiary Agreement on Science and Technology Development, 1985*

Objective

To establish university-industry liaison offices at each of British Columbia's three public universities. A total of $4 million over five years contributed equally by Canada and the Province, will be allocated to this program.

Rationale and Description

The transfer of technological knowledge and innovation from universities to industry is a critical step in high technology industrial development. This program will place increased emphasis on the application of university research and development to existing industry.

The effort is seen as an extension of the concept already developed in British Columbia. Through the activities of the Discovery Foundation and the Science Council of British Columbia, a B.C. Innovation Office has been established where entrepreneurs and innovators are encouraged to commercialize their inventions. University-industry liaison offices will provide equivalent services at each of the three public universities. It will establish a vital link between the university researcher and industry in an effort to facilitate the transfer of technological know-how from basic science to commercialization. The B.C. Innovation Office, together with the Discovery Foundation and the Science Council will be involved in supporting this venture.

A total of $4 million over five years will be used to support the establishment of university-industry liaison offices as well as the essential staff they will require. It is anticipated that basic space for the activities will be contributed by the universities themselves.

Implementation

This program will be implemented by either Canada or the Province or jointly at the discretion of the Management Committee. The Management Committee will be responsible for ensuring that support under this program complements that available from other sources for the same purpose. Canada will not be responsible for any operating costs associated with this program beyond the terms of this Agreement.

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* As taken from the text of the agreement.

Appendix 4. The Industrial Interaction Strategy of the University of Guelph, 1982

The following recommendations are listed in The Industrial Interaction Strategy of the University of Guelph (Office of Research, March 1982). All but the last one have been approved or implemented to act as guidelines for university personnel on matters relating to industrial interaction and to facilitate industrial interface activities.

1. that the University, while continually striving for excellence in its academic programs, expand its industrially-supported research and other related technological assistance activities;

2. that the University develop appropriate policies, procedures and guidelines for the University as a whole and particularly at the department level for managing industrial interactions so that industrially sponsored activities are accepted under terms and conditions which retain continued excellence in academic programs and an optimum degree of freedom in scholarly activities;

3. that the Research Board periodically assess and report to Senate on the impact of industrially-supported research and technological assistance activities on the University's academic programs, and recommend any adjustments that may be required either in the type and level of such activities or in the policies, procedures and guidelines by which they are governed;

4. that the University assist the City of Guelph and surrounding area by participating in programs to help develop existing industry and attract new industry;

5. that the University, in marketing its research and technological assistance activities to industry, initially stress areas in which excellence and depth of capability have already been demonstrated, focussing its efforts on those industrial sectors for which these areas are most applicable, and develop procedures to respond to requests for assistance in other areas of the University where there is strength and competence;

6. that the University continue to encourage technology transfer through contract research by considering any contribution to scholarly activity that is generated through patents and other successful activities in research and development on industry-related projects when assessing the performance of University personnel;

7. that the University continue to encourage social technology transfer through contracts research by considering any contribution to scholarly activity that is generated through successful activities in policy studies, technology assessment, program evaluation, design, etc., when assessing the performance of University personnel;

8. that the University encourage technology transfer and social technology transfer through technological assistance activities by accepting such activities which benefit departmental programs as evidence of service to society and the University when assessing the performance of University personnel;

9. that prices for research and technical assistance represent fair value to clients and reflect the full cost of performing the work, so that the University is neither subsidizing its clients, nor competing unfairly with private technical service companies. The University's prices will reflect the extent to which an industrial research project brings scholarly benefits to the University's academic programs, and also

the demand for such industrially-related services;

10. that a Director of Industrial Services be appointed to coordinate the development of University policies, structures and strategy concerning research and technological assistance activities for industry; to represent the University on industry-related research and technology matters; to assist University researchers in linking with industrial partners; to coordinate the commercial development of University innovations; and to assist in proposal development and presentation. The Director will report administratively to the Dean of Research;

11. that the University consider the establishment of a financially independent, University-owned corporation to assist University personnel in the marketing of commercial services in consulting, program management and technology licencing, so that the University could respond efficiently to the industrial need for such services without modifying its own priorities, policies or organizational structures. Such a corporation would be created only if a viable business plan can be developed, and if its proposed charter and by-laws contain sufficient safeguards to ensure that its operation does not conflict with the objectives of the University.

NOTES

1. George Wise, "Science and Technology," Osiris 1 (1985), 229-246, 229-230; Nathan Rosenberg, "How exogenous is science?", in his Inside the Black Box: Technology and Economics (Cambridge University Press: Cambridge, 1982), 141-159, 156; Deborah Shapley and Rustum Roy, Lost At The Frontier: U.S. Science and Technology Policy Adrift (Philadelphia: ISI Press, 1985), 18-20.

2. "Official Report of Manufacturers' Convention - Resolution on Industry and Higher Education," Industrial Canada 1 (1900-1901), 64.

3. Marni de Pencier, "Ideas of the English-Speaking Universities in Canada to 1920," PhD dissertation, University of Toronto, 1977, 653.

4. See, for instance, Philip C. Enros, "The University of Toronto and Industrial Research in the Early Twentieth Century," in Critical Issues in the History of Canadian Science, Technology and Medicine, eds. R. Jarrell and A. Roos (Thornhill, Ontario: HSTC Publications, 1983), 155-166, and James P. Hull, "Science and the Canadian Pulp and Paper Industry 1903-1933," PhD dissertation, York University, 1985.

5. Stanley B. Frost, McGill University, For the Advancement of Learning. Volume 2, 1895-1971, (Montreal: McGill-Queen's University Press, 1984), 40-41.

6. Scott and Astrid Young, O'Brien (Toronto: Ryerson Press, 1967), 110-111, 173-175.

7. See, for instance, Paul Axelrod, "Higher Education, Utilitarianism, and the Acquisitive Society: Canada, 1930-1980," in Modern Canada 1930-1980's, eds. Michael S. Cross and Gregory S. Kealey (Toronto: McClelland and Stewart Ltd., 1984), 179-205.

8. For example, the publications of the Corporate-Higher Education Forum and of the Bovey Commission; the terms of reference of the Ad Hoc Advisory Committee on Basic Research in Ontario Universities; the Canadian Manufacturers' Association Task Force on Business-Education Relations in Canada; NSERC's second five-year plan; the (Wright) Task Force on Federal Policies and Programs for Technology Development; the Council of Ministers of Education, Canada, Changing Economic Circumstances: The Challenge for Postsecondary Education and Manpower Training; and numerous articles in academic, business, and popular magazines.

9. University of Calgary, Report of the Technology Transfer Committee, Expanding Horizons: A Strategy for Transfer of University Research and Innovation (Calgary, 1983), 11.

10. George Keller, Academic Strategy: The Management Revolution in American Higher Education (Baltimore: Johns Hopkins University Press, 1983). For the social sciences in particular see John E. Trent, "Editorial: Social Science Research in Canada: The Next Step Forward," The Canadian Journal of Higher Education 14:3 (1984), 1-9, 4.

11. Michael L. Skolnik and Norman S. Rowen, "Please, sir, I want some more" -: Canadian Universities and Financial Restraint (Toronto: Ontario Institute for Studies in Education, 1984), 4.

12. For lists of these mechanisms see Judith Maxwell and Stephanie Currie, Partnership For Growth: Corporate-University Cooperation in Canada (Montreal: Corporate-Higher Education Forum, 1984), or Lynn G. Johnson, The High Technology Connection: Academic/ Industrial Cooperation for Economic Growth (Washington, D.C.: Association for the Study of Higher Education, 1984).

13. Maxwell and Currie, op. cit. (note 12), 5.

14. Johnson, op. cit. (note 12), vi-vii, xv. For a discussion of Canadian opinions about the barriers and benefits see Corporate-Higher Education Forum, Spending Smarter: Corporate-University Co-operation in Research and Development (Montreal, 1985).

15. IDEA Corporation, "A Five-Point Plan for Commercializing University Research in Ontario," a statement by H. Ian Macdonald, chairman of the board, IDEA Corporation, 21 September 1984, to the Commission on the Future Development of the Universities of Ontario, 6.

16. NSERC, Completing the Bridge to the 90's: A Second Five-Year Plan for the Programs of the Natural Sciences and Engineering Research Council (Ottawa, 1985), 1: 58.

17. Op. cit. (note 15), 4-6.

18. Op. cit. (note 9), i-ii.

19. Jana B. Matthews and Rolf Norgaard, Managing the Partnership Between Higher Education and Industry (Boulder, Colorado: National Centre for Higher Education Management Systems, 1984), 148.

20. Niall J. Gogan, "The Development of Research Administration and Management in Canadian Universities," manuscript prepared for the Science Council of Canada (Ottawa, 1985), 27; see also P.A. Larkin, "Who's on First: A Survey of Organization for Research Policy and Research Administration at Canadian Universities," paper presented at the annual meeting of the Canadian Association of University Research Administrators, Ottawa, May 1981.

21. Gogan, ibid., 21.

22. Op. cit. (note 19), 99.

23. Herbert I. Fusfeld and Carmela S. Haklisch, "University-Industry Research Interactions. A Guide to the Proceedings," Technology in Society 5 (1983), 157-163, 161.

24. Johnson, op. cit. (note 12), 10-11.

25. Ernest A. Lynton, "Reexamining the Role of the University: A Crisis of Purpose," Change 15:7 (October 1983), 18-23, 53, 53.

26. L.-P. Bonneau and J.A. Corry, Quest for the Optimum: Research Policy in the Universities of Canada, report of a commission to study the rationalization of university research, (Ottawa, Association of Universities and

Colleges of Canada 1972), 1: 105, 40.

27. Gogan, op. cit. (note 20), 16-17.

28. A discussion and list of these institutes may be found in J.B. MacAulay and P. Dufour, The Machine in the Garden: The Advent of Industrial Research Infrastructure in the Academic Milieu (Ottawa, Science Council of Canada, 1984), 43-45.

29. University of Guelph, The Industrial Interaction Strategy of the University of Guelph (Guelph, 1982), 2.

30. Matthew Bullock, Academic Enterprise, Industrial Innovation, and the Development of High Technology Financing in the United States (London: Brand Brothers & Co., 1983), ii.

31. DRIE, Program Evaluation Branch, "Technology Centres Evaluation Assessment," (March 1985), ii.

32. Ibid., 4.

33. Gordon Maclachlan, "The Ivory Tower is Leaning Towards Industry," speech delivered at the 23rd annual conference of the Canadian Research Management Association, September 1985, Jasper, Alberta, 3.

34. For examples of barriers in Canada, see Corporate-Higher Education Forum, op. cit. (note 14).

35. W.E. Tossell, J.A. McPherson, and F.W. Maine, The faculty survey as a tool in planning a university's industrial interface strategy (Guelph: University of Guelph, 1982).

36. James B. MacAulay, An Indicator of Excellence in Canadian Science (Ottawa: Statistics Canada, 1985), 24.

37. National Research Council, A Practical Perspective: The NRC Plan 1986-1990 (Ottawa, 1985), 63.

38. J.A. McPherson, "Commercializing University R&D," paper delivered at a Financial Post Conference, Toronto, 14 November 1984, 7.

39. Ministry of State for Science and Technology, "Science, Technology and Economic Development," a working paper prepared for the Federal-Provincial Meeting of Ministers responsible for Science and Technology, Calgary, 4-5 February 1985; and see also its 16 September 1985 news release: "Science and Technology Ministers Meet at Meach Lake."

40. Louis G. Tornatzky et al., The Process of Technological Innovation: Reviewing the Literature (Washington, D.C.: National Science Foundation, 1983), quoted in Johnson, op. cit. (note 12), 44.

41. M.E.D. Raymont and E.L. Holmes, "Dynamics of Technology - The University Perspective," paper delivered at a symposium, "The Dynamics of Technology," organized by the Collins Group, 1985, 3.

42. See, for example, Gilles Drouin, "Université-industrie: sarrau blanc et attaché-case," Québec Science 23:10 (June 1985), 14-21.

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